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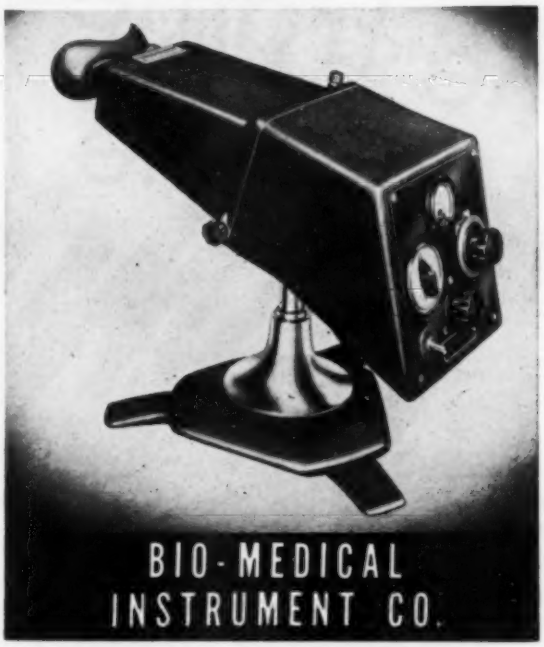

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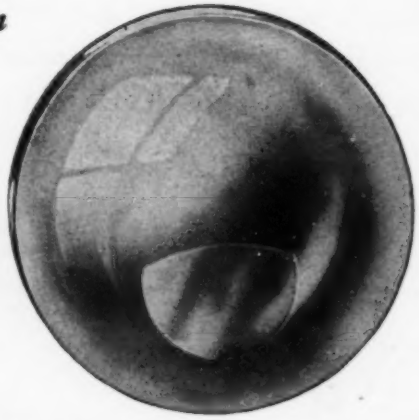

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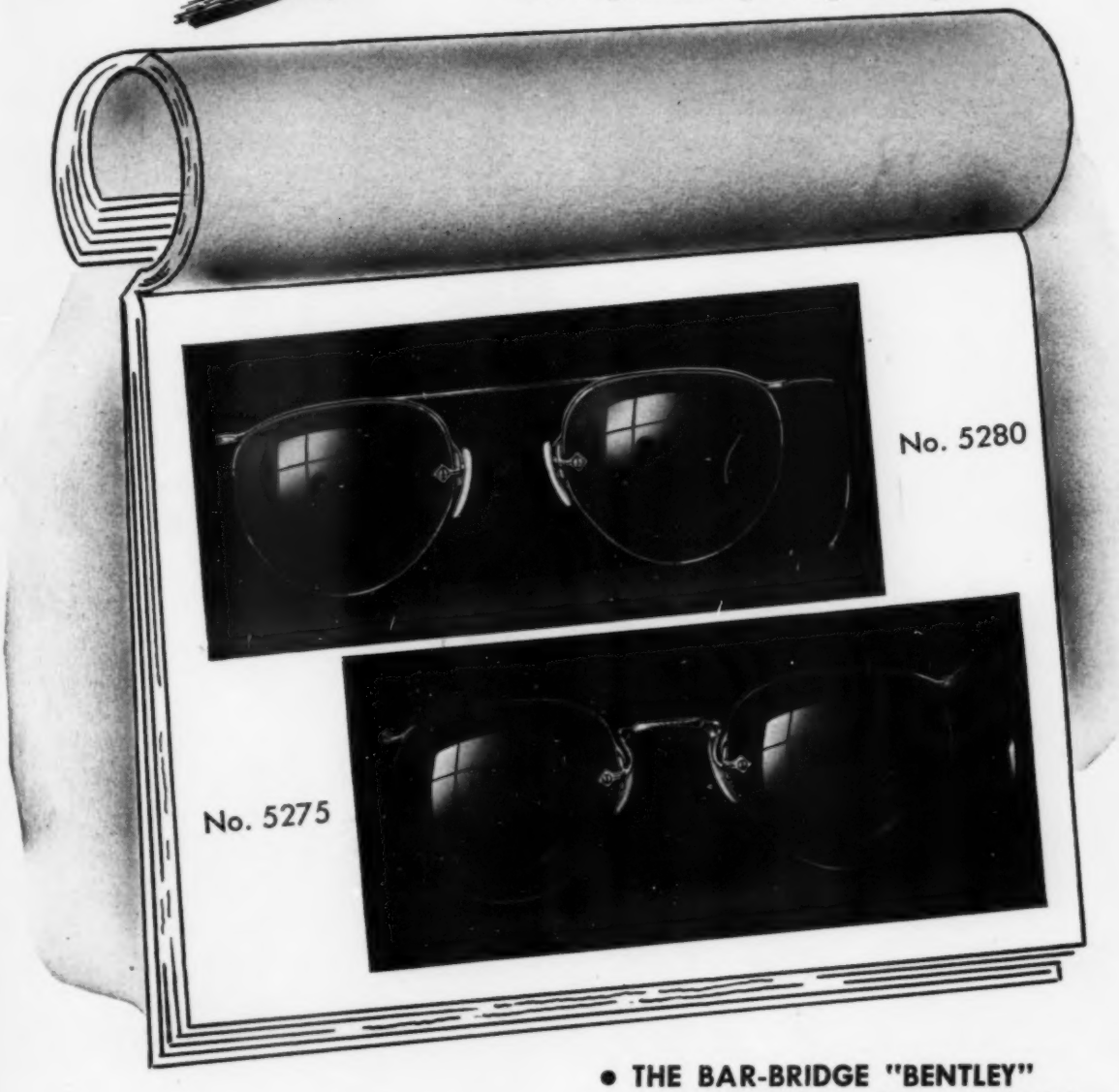

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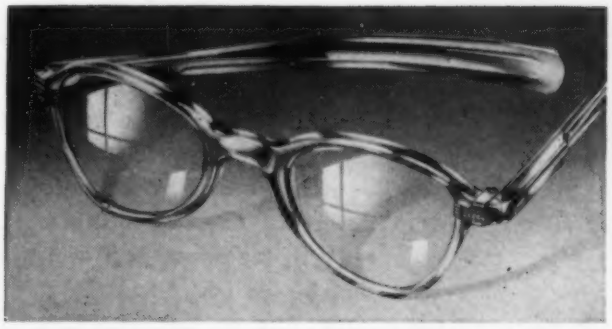

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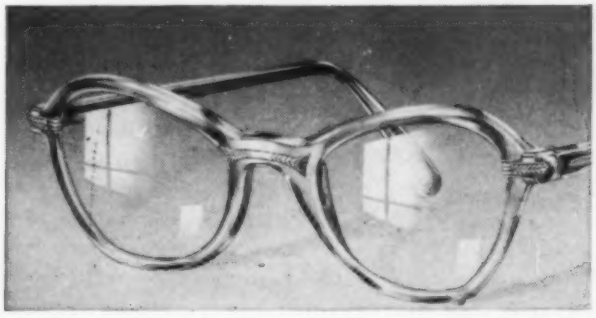

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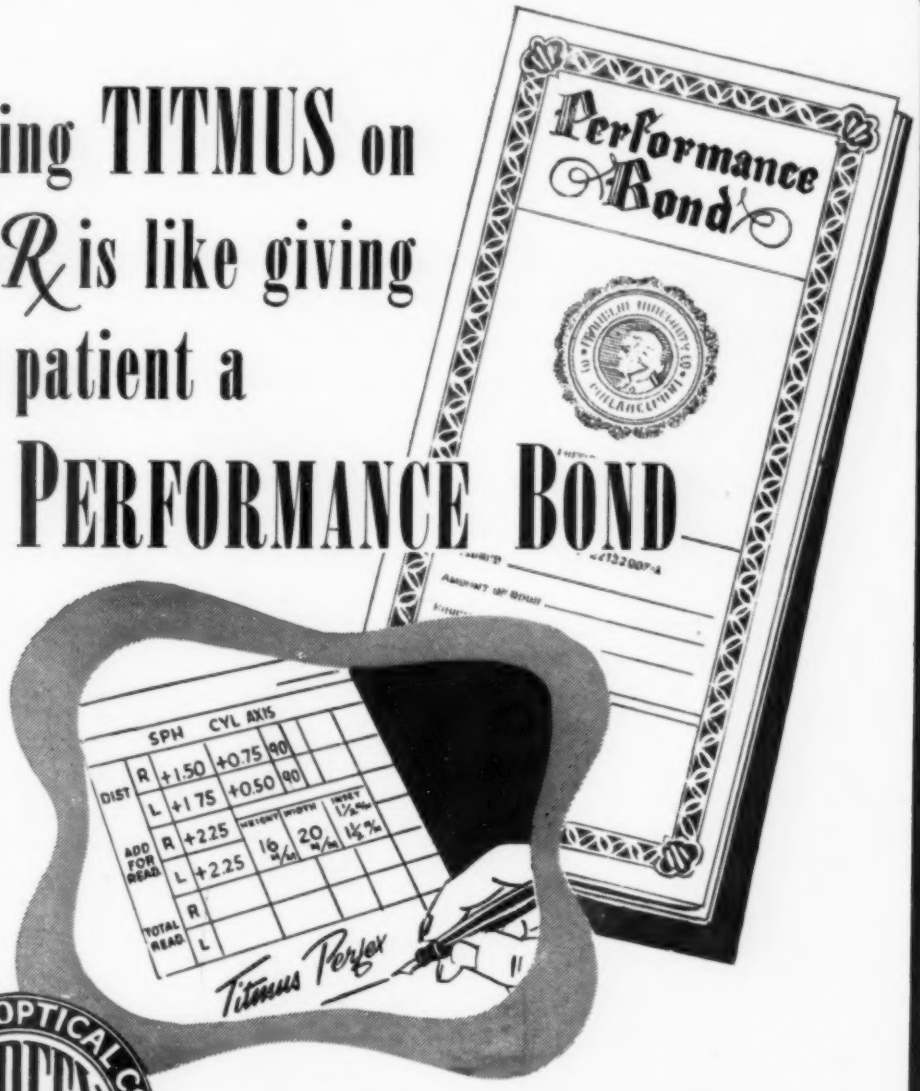

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Vol. 25 SEPTEMBER, 1948 No. 9

THE EFFECT OF TESTING METHOD ON VALUES OBTAINED FOR PHORIA AT FORTY CENTIMETERS*

Monroe J. Hirsch† and Lois B. Bing‡
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Columbus, Ohio

One reason for the discrepancy in average value for the phoria at 40 cm. found by different investigators may be the different techniques employed, for in phoria measurement as in other psychophysical phenomena the value obtained is to some extent a function of the stimulus. Average values range from —6.6△[a] found by the Bureau of Visual Sciences[1] on 48 subjects to —1.02△ for 100 subjects tested by Bannister.[2] Other average values worthy of mention are those of Haines[3] on 1,000 subjects of —4.85△; Vivian[4] on 2,172 subjects of —3.96△; Eames[5] on 302 cases of —2.21△; Morgan[6] on 800 subjects of —3△; and Shepard[7] of —5△. The standard deviation of these measurements is close to 4.5△, although Weymouth, Brust and Gobar[8] report a value somewhat higher, and Clark[9] a lower value, due perhaps to the greater homogeneity with respect to age and occupation of the latter's patients.

Scobee and Green[10] have recently conducted a thorough investigation of methods of measuring the phoria at 6 M. as well as at 40 cm. The mean values and standard deviations for the five methods of measuring phoria at 40 cm. used by them are:

Method	*Mean*	*Standard Deviation*
Screen and parallax	—8.2△	7.4△
Screen Maddox rod	—5.9△	5.8△
von Graefe prism diplopia	—3.0△	5.2△
Maddox wing	—3.0△	3.4△
Thorington	—2.8△	4.3△

*Submitted on May 28, 1948, for publication in the September, 1948, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

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[a]For uniformity and simplicity, a minus sign (—) will indicate exophoria, while a plus sign (+) indicates esophoria.

Before attempting to discuss the advantages of the various techniques, it would be well to consider the interpretation which is placed upon the measure. The phoria at 6 M. assumes no accommodation in play, while the phoria at 40 cm. assumes 2.50 D. of accommodation to be in play. From these two measures, the A. C. A. ratio or the accommodative-convergence gradient[b] may be calculated. This gradient or ratio is the number of prism diopters of convergence stimulated by each diopter of accommodation. For this purpose, the most desirable measure of phoria at 40 cm. will be one which as nearly as possible entails the use of full accommodation for the target. An example should clarify this point: Assume that the 40 cm. phoria was found to be —9△ for an individual, orthophoric at 6 M. It would be said that 6△ of convergence had been stimulated along with the 2.50 D. of accommodation, and the A. C. A. ratio or gradient would be 2.4△ of convergence per diopter of accommodation. However, if the subject had only been accommodating 1.50 D. instead of the 2.50 which was assumed, the true ratio or gradient would be 4△ of convergence per diopter of accommodation. Had the subject been fully accommodating for the target, the phoria at 40 cm. would have been —5△. Clearly, then, it is important in testing that the subject accommodate as nearly the full amount for the stimulus as is possible.

On the basis of the above discussion, it is seen that the higher exophoric values obtained by Scobee and Green for the screen and parallax test and the screen Maddox rod test may well be due to the fact that full accommodation is not necessary to satisfy the test. In these tests it is only necessary for the individual to be aware of the test object, and under such conditions full accommodation for the stimulus distance may not be brought into play. The other tests all require apprehension of fine detail, and hence within the limits of the depth of focus, the individual may be expected to be fully accommodated when he reports seeing clearly.

In accordance with the above a number of criteria of a good test for phoria at 40 cm. may be set up:

a. To as great an extent as possible the test should require accommodation equal to the reciprocal of the stimulus distance.

b. The test should be repeatable, different examiners as well as the same examiner at different times getting similar results.

c. The test should be one that may be easily administered in the course of an ocular examination.

---

[b]The former term used in clinic at the Ohio State University while the latter is used at the University of California.

From the data of Scobee and Green, we see that the screen and parallax test and the screen Maddox test do not satisfy condition *a*, both exhibiting a considerable degree of exophoria more than the other three. The Maddox wing test requires special apparatus, and it would be difficult to include the patient's prescription. It does not satisfy condition *c* as well as the others. The present study is designed to determine whether there is any difference between the two remaining tests, and if so which test is preferable, the Thorington test or the prism diplopia test.

Procedure: Each of 38 senior students in the School of Optometry at the Ohio State University was measured by two testers, one a staff member, and the other a senior student at the Optometry Clinic. On another occasion, each subject was again tested by each of the two examiners. Three tests, to be described, were made in rapid succession at each testing, always in the order in which they are described below. The actual procedure was carefully discussed by the two examiners, and every effort was made to have both examiners use the same technique.

Test 1: *The von Graefe prism diplopia test with the large letter E as fixation target*: The subject was seated behind the phorometer, and an 8△ prism, base-down was placed before the right eye. During the entire series, the same vertical prism was used, and was always placed before the right eye. Before the left eye, a Risly prism, set at about 20△ base-in, was placed. The reading card, set at 40 cm. was a reduced Snellen chart, with a thin line frame around it. The subject was instructed to watch the 20/200 "E"; the lateral prism was slowly reduced in power, and the subject was asked to report when one "E" was directly above the other.

Test 2: *The von Graefe prism diplopia test with the smallest legible line as fixation target*: The test was done in exactly the same manner as Test 1, except for the instructions to the subject. Instead of fixating the large "E," the subject was instructed to find the lowest line which he could read in the upper image. He was now instructed to read this line slowly forward and backward until the two images were vertically aligned, at which time he was to so report to the examiner.

Test 3: *The modified Thorington test*: The test card, placed at 40 cm. was one on which was printed a horizontal line, divided into 4 mm. segments by tiny vertical lines. Above each line on one side were numbers from 1 to 15, and on the other side letters from A to O. A small hole, at the zero position, allowed an exposed ophthalmoscope bulb mounted behind the card to be seen. A white, multiple Maddox rod was placed before the right eye, with its cylinder axes horizontal,

so that a vertical white streak was seen by the right eye, whereas the letters and numbers on the card were seen by the left. The illumination on the card was the same in this as in the preceding two conditions. The subject was instructed to begin with the letter O, and slowly read the letters, going toward the middle, stopping when he reached the letter closest to the white streak. He was then asked to begin with the number "15," and again read toward the middle. If the value obtained by both methods was the same, it was recorded. If not, the subject was asked to look at the letters or numbers reported in the two previous parts, and carefully choose the one letter or number which was closest to the white streak. Each division, of course, represented one prism diopter, the numbers, esophoria and the letters, exophoria.

Results: The primary data for the experiment consist of 12 near point phoria measures (three methods, two testers, two tests for each tester) for each of 38 subjects. The following abbreviations will be used: For the first test by Bing, B_1 and for the retest by this examiner, B_2; for the first test by Hirsch, H_1 and for the second or retest, H_2; for the modified Thorington test *T*, for the prism diplopia test with the E fixated *E*, and for the prism diplopia test with small letters fixated *L*. The mean and standard deviation expressed in prism diopters for the group for each test and each observer are presented in Table 1.

TABLE 1

Means and standard deviations for two examiners (H & B), three tests (E, L & T), and retests (1 & 2), for 38 observers.

Test	*Examiner*	*Trial*	*Mean*		*Standard Deviation*
E	H	1	—3.9 Δ		4.6 Δ
E	H	2	—3.2 Δ		4.5 Δ
E	B	1	—5.4 Δ		5.2 Δ
E	B	2	—4.4 Δ		5.1 Δ
E	Average of above 4		—4.22Δ	±0.39Δ	4.85Δ
L	H	1	—4.7 Δ		5.3 Δ
L	H	2	—3.5 Δ		5.2 Δ
L	B	1	—5.3 Δ		5.6 Δ
L	B	2	—5.1 Δ		5.3 Δ
L	Average of above 4		—4.64Δ	±0.43Δ	5.35 Δ
T	H	1	—3.2 Δ		4.2 Δ
T	H	2	—3.2 Δ		4.7 Δ
T	B	1	—3.7 Δ		3.9 Δ
T	B	2	—3.7 Δ		3.8 Δ
T	Average of above 4		—3.36Δ	±0.34Δ	4.21 Δ

In general, examiner H tended to find less exophoria than examiner B, but the sample is small, and the differences are not great. Dealing with the combined data, we find that the mean values were —4.22Δ

for test E; —4.64△ for test L, and —3.36△ for test T. The probability that differences as large as those observed could have resulted by chance are as follows:

Tests	*Difference*	*Probability*
E and L	0.42△	.02
E and T	0.86△	< .0001
L and T	1.28△	< .0001

We may then conclude that in the present experiment, the prism diplopia test showed more exophoria when the letters were fixated than when the E was fixated, the amount, however, being an average of less than half a prism diopter, and the level of significance being only 2 per cent. It would seem that for practical purposes it would be safest to conclude that no difference occurred. Whatever the case, however, it seems equally safe to conclude that having the subject read the small line of type instead of fixating the E did not increase the amount of accommodation and consequently convergence in play. On the other hand, test T does seem consistently to show approximately one diopter less exophoria than either of the other tests, and this difference, while slight, is statistically significant to the one in 10,000 level. Since the average amount of convergence brought into play by a diopter of accommodation is approximately 4△, we may conclude that a rough estimate would indicate approximately 0.25D. more accommodation in play during the Thorington test than during either of the prism diplopia tests. This difference, while small, could have occurred by chance less than once in ten thousand times.

The reliability coefficients for each of the tests and the consistency between examiners will be considered next. The reliability coefficient is usually defined as the test-retest correlation coefficient. In Table 2, below, are presented the correlation coefficients along with the number of cases upon which each is based.

TABLE 2

Constant Factor	*Variable 1*	*Variable 2*	*Number*	
Test E	H_1	H_2	38	.76
Test E	B_1	B_2	38	.88
Test L	H_1	H_2	38	.88
Test L	B_1	B_2	38	.88
Test T	H_1	H_2	38	.88
Test T	B_1	B_2	38	.93
Test E	H_1 and H_2	B_1 and B_2	76	.94
Test L	H_1 and H_2	B_1 and B_2	76	.94
Test T	H_1 and H_2	B_1 and B_2	76	.94
H_1, H_2, B_1, and B_2	Test E	Test L	152	.90
H_1, H_2, B_1, and B_2	Test E	Test T	152	.85
H_1, H_2, B_1, and B_2	Test L	Test T	152	.92

Analysis of the six test-retest correlations yields the following: In all cases the test-retest correlations were significantly[c] different from zero, and no one of these differed significantly from any other. There was higher correlation for Test T (.88 and .93 for the two examiners) and lower for Test E (.76 and .88). It is again stressed, however, that even the difference between extremes did not reach a level of statistical significance, although a larger sample might yield a significant difference. It should further be pointed out that due to the small sample a single poor case can exert a decided effect upon the coefficient obtained. One such case in the present data was a high esophore. Omitting this case from the calculation, for example, will raise the correlation for Test E between H_1 and H_2 from .76 to .83. Thus correlation technique only enables us to make a cautious statement to the effect that the trend indicated was for greatest reliability for Test T, and least for Test E.

The second series of correlations—that between examiners—exhibited no difference between tests, all being .94. Considering this and the test-retest results, it is striking that all tests are so reliable and consistent for different examiners. The impression commonly held that the test for phoria at near is at best a poor one seems to be unfounded if the test is carefully made and the instructions to the subject are clear and understood. In psychophysics generally, few tests yield coefficients higher than these for measurements based upon so few trials.[d] Weymouth and Hirsch[11], for example, measuring distance discrimination by various modifications of the Howard technique, found the following retesting coefficients: 0.88 for thresholds based upon 300 observations, 0.62 based upon 3 observations, 0.86 based upon 10 observations, 0.60 and 0.69 each based upon 25 observations.

The third group of correlations, those between tests are also surprisingly high. In addition to the fact that all are tests of the same variable, the phoria at near, certain elements are common to two of the tests only. Thus, Test E and Test L have in common the prism diplopia technique, and the task demanded of the subject, namely, reporting of vertical alignment. Test L and Test T have in common the demand for close scrutiny of the stimulus, whereas in Test E the subject is merely asked to watch the E. The three correlations each differ significantly

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[c]Significancies were in all cases determined by Fisher's Zr method. See R. A. Fisher. Statistical Methods for Research Workers. 1936, Section 35.

[d]For the prism diplopia tests only a single trial was used. For the Thorington test, no more than three trials were used. The number of trials was, however, limited to two if agreement occurred, which is equivalent to extra trials—how many more cannot be stated. This is a flaw in the design of the present experiment which occurred due to the simplicity of the Thorington test and the possibility of taking two measurements in the time usually required for one prism diplopia measurement. This flaw has been eliminated from the experiment later to be described.

from zero, but only the difference between .85 and .92 reach the 1 per cent significance level. The difference between .85 and .90 could have occurred by chance seven times in 100. This seems to indicate that tests which demand close attention to the stimulus (maximum effort of accommodation) yield more similar results than those which do not. Also similarity in procedure leads to similarity in results but is not as important a factor as is control of accommodation.

In general, it should be stressed that no very striking differences were demonstrated by correlational technique. However, there are weaknesses in such a technique. Consistent differences do not reduce the correlation coefficient. Thus if one examiner had consistently found 3 prism diopters more exophoria than the other, the correlation coefficient could still have been unity. The correlation between x and $x + constant$ is equal to 1.00. However, if such a difference were present in certain tests only, it would be well to know. Such a constant error could be demonstrated by presentation of the regression formulae. Simpler of interpretation, however, would be an analysis of the differences, and this technique was chosen.

The technique involved is rather simple. If it is desired to know whether H_1 and H_2 agreed more closely for test E or for test L, the following could be done: find the difference in score between H_1 and H_2 for each subject in test E. This would give 38 differences. The same is done for test L, also yielding 38 differences. These may now be considered as two distributions and the mean and standard deviation of each may be calculated. The test having the lowest mean or average error is of course the best test, and the difference between the two average differences may be tested for significance just as any two means might be tested.

The differences between test and retest for each of the two examiners for each of the three tests has been calculated. The average difference, and the standard deviation of the distribution of differences are presented in Table 3.

TABLE 3

Test	*Examiner*	*Average Difference*	*Standard Deviation*
E	H	2.32Δ	2.26Δ
E	B	2.05Δ	1.69Δ
L	H	2.16Δ	1.84Δ
L	B	2.05Δ	1.75Δ
T	H	1.37Δ	1.76Δ
T	B	1.16Δ	1.10Δ

We are interested here in knowing whether any of the tests showed less average difference than any other. Examination of Table 3 reveals

such a difference. Clearly, the average difference between test and retest for test T was considerably less than the average difference for either of the other two tests. Tests for significance reveal that the differences between test E and test L might easily have resulted from chance in the case of examiner H where the L test was 0.16△ lower; for examiner B, there was no difference between test L and test E, each yielding an average difference of 2.05△. The difference between test T and either of the other tests, for either examiner was statistically significant to less than the half per cent level; i.e., there was less than one chance in two hundred that differences as large as these could have resulted by chance.

The practical interpretation of the above may be stated as follows: Each of the three tests was run twice, and the difference between the two trials was recorded. The average difference for test E and test L was a little over 2△, while for test T, the average difference was slightly over 1△, i.e., on an average this test gave differences of one prism diopter less. The standard deviations of the average differences, it will be noted, are almost as large as the means. There is then positive skew to the distributions of differences, and hence some differences much larger than the mean were found. It should again be mentioned that thresholds for Test T were based upon more than a single observation.

A similar analysis of the difference between examiners yielded similar results. Combining first and second test and determining the difference between the examiners yielded the following mean differences: for test E, 2.12△, for test L, 2.00△, and for test T, 1.14△. Further analysis seemed unwarranted in view of the small sample.

Discussion: A good test for near point phoria, it was stated earlier would be one which (a) most accurately controlled accommodation, and (b) yielded similar results when repeated by the same examiner, or different examiners. On the basis of correlation technique, there seems to be no significant difference between the three tests, insofar as repeatability is concerned, although test E seems to be the poorest and test T the best. There was no difference at all insofar as different examiners were concerned. Perhaps the most significant point is the magnitude of all of the correlations, compared to other psychophysical determinations.

Insofar as accommodative control was concerned, the mean phoria value for test T showed significantly less exophoria than did the other two tests, which in turn did not differ greatly from each other, the difference (significant to the 2 per cent level) being for more exophoria in test L than in test E. One possibility is that more accommodation (approximately 0.25 D.) was in play for test T than for either of the other tests. Other possibilities are the different degrees of dissociation and the reaction time.

Conclusions: Due to the small sample, and the fact that only trained observers (optometry seniors) were used, any conclusions will be of a tentative nature. While there are certain advantages in selecting trained, critical subjects for a preliminary study, it is dangerous to generalize from the results. The authors look upon the present experiment as an exploratory investigation.

A. The most striking single conclusion is perhaps the high reliability of all of the phoria tests. When one considers that only a single measurement was taken for the prism diplopia test and no more than three for the Thorington, this fact becomes even more significant. Any claim of lack of repeatability of the phoria at 40 cm. would seem to be unfounded, the measure being quite stable.

B. In general, the modified Thorington seems to be slightly more reliable, although by an amount not statistically significant. Analysis of the differences did reveal an average difference between test and retest which was significantly lower than either of the other tests. On this basis, it is tentatively concluded that it is better clinically than is the prism diplopia test, regardless of how accommodation is controlled in the latter.

C. The fact that the average phoria at near was in the direction of less exophoria when the E was fixated than when the letters were read is difficult to explain. Attention should be called, however, to the fact that the difference was small, being only 0.42△. It is possible that the observers, being trained in optometry, fixated the E with great care, and hence used as much accommodation as they did in reading the small letters. A difference in the opposite direction may show up if regular clinic patients are used as subjects.

D. There are a number of possible explanations for the lesser amount of exophoria for the modified Thorington test. The effective power of prisms is somewhat less than the actual prism reading. Calculations based upon a correction factor of 0.9^{12}, reveal, however, that this could account for only about half of the difference obtained. It seems probable, therefore, that the stimulus to accommodation offered by this test is slightly more demanding of the full accommodation than is the stimulus offered by the other two tests. In the modified Thorington test, the task of naming the letter through which the line passes might logically be expected to demand more nearly full accommodation than the test in which the task is twofold, i.e. reading the letters and watching for alignment. In the latter test there may be a slacking off on the reading of the letters (and a slight relaxation of accommodation) as the position of vertical alignment is approached. Whatever the case it should be stressed that while the modified Thorington test did show

slightly less exophoria than the others, the amount was only of the order of 1△.

A further investigation of the tests mentioned in this paper is now in progress at the Ohio State University Optometry Clinic to determine whether the tentative conclusion as to the relative merits of the various tests is tenable; to attempt to improve upon these tests; and to standardize the results clinically, i.e. to establish a mean value and limits. The new test card being considered will have a number of lines of type so that a maximum stimulus to accommodation will be afforded. Each patient will be measured twice within an hour by both the prism diplopia test and the modified Thorington test, using a single trial for each test.

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THE CORRECTION LENS*

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PART IV

Types of Bifocal Lenses.
Jump and Displacement in Bifocal Lenses.
Trifocal Lenses.
Occupational Lenses.
Single and Binocular Loupes.
Telescopic Systems.
Bibliography.

TYPES OF BIFOCAL LENSES

The optical industry produces two principal types of invisible or nearly invisible bifocal lenses, namely: the fused bifocal lens and the one-piece bifocal.

The fused lens consists of two separate parts, the distance lens, and countersunk and fused into its lower portion the button consisting of glass of higher index. In the conventional Kryptok, Figure 54, the material of the distance lens is standard crown glass of index 1.5232 and that of the button is flint glass index of about 1.65. Expressing the power of the button in terms of tools trued for the crown index, we find that

$$S_{CR} = \frac{n_C - 1}{n_F - n_C} \times \text{ADDITION}$$

Where n_c is the index of the crown (about 1.5).
n_f is the index of the flint (about 1.6).

Assuming these approximate values, we find that the nominal power of the button is five times that of the addition. If the addition is 2 D and the outside curve is 6 D, the inside curvature of the button expressed in tools trued for crown glass is about +4 D. Figure 54. The true power of the flint button is, of course, higher, namely:

$$S_F = \frac{n_F - 1}{n_F - n_c} \times \text{ADDITION}$$

The correction for color aberration of positive achromatic systems demands that a positive crown lens be combined with a negative flint

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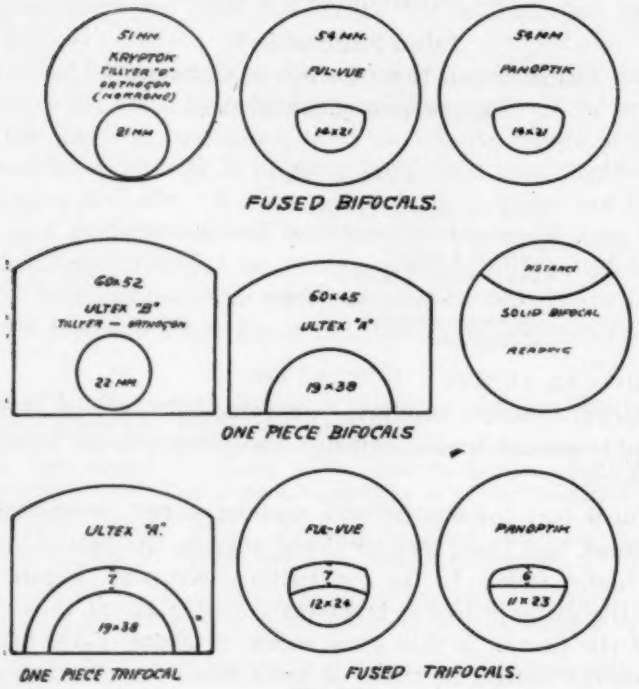


Fig. 53

lens of about one-half the power of the crown component. In a Kryptok lens with plus power for distance, just the opposite obtains and, therefore, such a lens tends to emphasize the chromatic aberration, a phenomenon well known to practitioner and wearer. The condition becomes

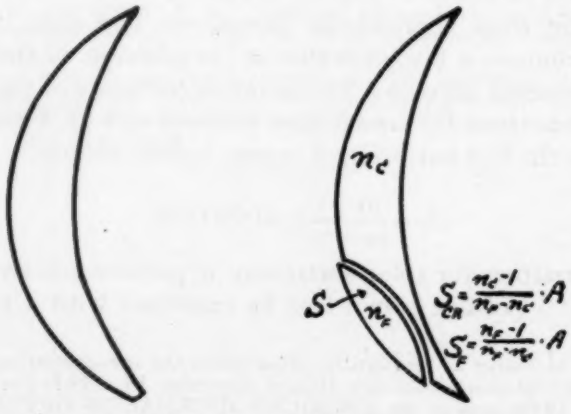


Fig. 54

better when the distance correction calls for minus power. To reduce these disturbing color fringes, the industry uses a high index crown glass with relatively low index of dispersion for the button, thus producing what is generally known as the "Nochrome" lens.

The problem of color fringes is practically eliminated in the one-piece bifocal type. In this lens the distance and reading addition are ground on the same piece of crown glass. The objection sometimes made is that the reading portion in the one-piece bifocal is not quite as invisible as in the fused type.

JUMP AND DISPLACEMENT IN BIFOCAL LENSES

When lowering our gaze from the distance to the reading portion of the bifocal lens, the visual axis passes through the dividing lines of these two parts and we experience double vision and a jump of the object of regard. This jump is dependent entirely upon the power of the reading addition and the distance of its upper edge from the center of the segment, Figure 55.

$$J^{\triangle} = A \cdot d \text{ (cm)}$$

Where J is the jump in prism diopters

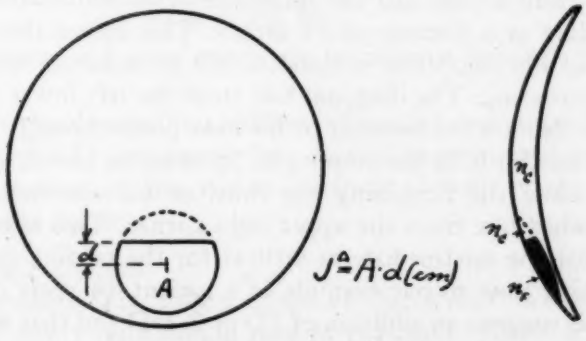
A is the addition in diopters.

d is the distance from the center of the segment to its upper edge in centimeters.

In general, the larger the segment, the greater the jump. For example, with a +2 D addition, the jump in an Ultex A is

$$2 \times 1.9 = 3.8^{\triangle}$$

In order to reduce the jump, the optical industry has produced the flat-top segment by fusing to the flattened upper edge of the button



JUMP IN BIFOCALS.

Fig. 55

a vertical extension of regular crown glass which becomes invisible in the finished lens.

The displacement of the center of the reading portion as measured from the center of the distance part was discussed in a previous chapter and was found to be:

$$a = \frac{Ad}{A+D}$$

Where A is the power of the segment
D is the power of the distance lens
d is the distance between the respective centers.

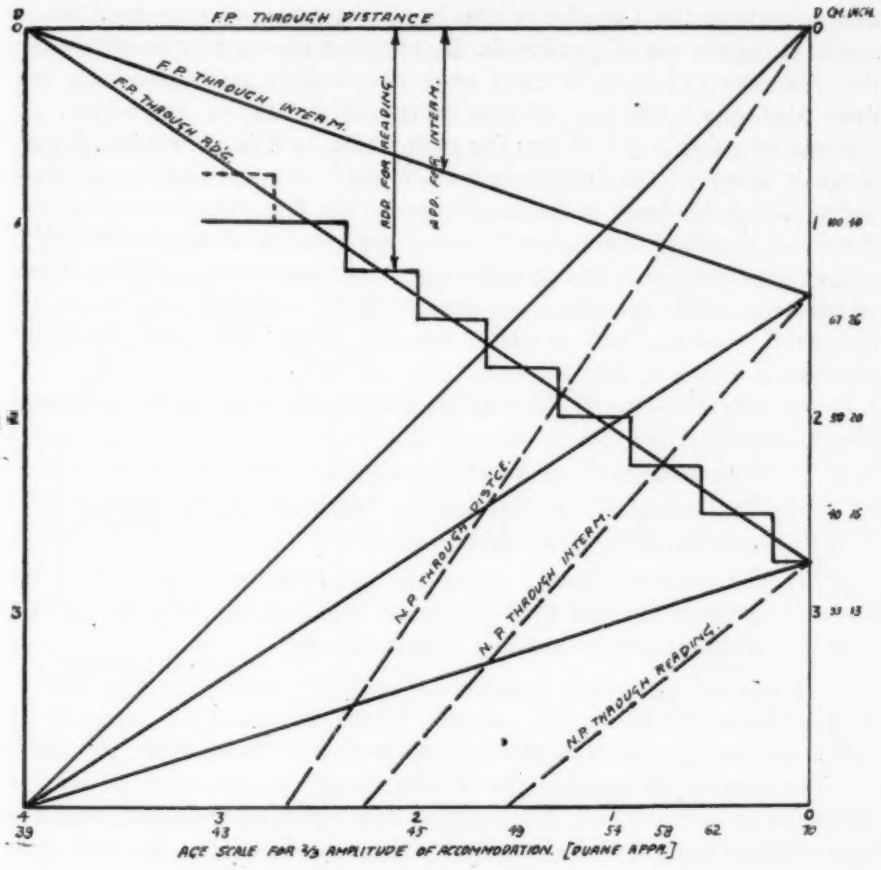
TRIFOCAL LENSES

A presbyope, 58 years old, may wear an addition of +2.00 D. Assuming most favorable conditions, he still can see fine print at a distance of about 20 inches through his reading portion, while looking through the distance lens his near point with an accommodative effort of 1 D would be at 40 inches. All objects between 20 and 40 inches will appear blurred unless he compensates for their distances by head movements. The purpose of trifocals is to diminish this handicap.

The intermediate zone is about 7 mm. wide and its dioptric power in most types is one-half of the reading addition. Again, as in the case of the bifocals, the trifocals are manufactured in the fused as well as in the one-piece type.

The trifocal diagram, Figure 56, suggested by Dr. Paul Boeder, gives an excellent picture of the range covered by the three parts of the trifocal lens. This particular diagram was constructed with the assumption that the maximum addition should be 2.75 D for a person 70 years old. It is also assumed that the patient can use, without any undue fatigue, one-third to one-half his amplitude of accommodation for continuous reading at a distance of 16 inches. This means that as long as two-thirds of his amplitude is equal to 4D or more, he does not need any help for reading. The diagonal line from the left lower to the right upper corner denotes the location of his near point through the distance lens using two-thirds of his amplitude. In order to obtain the ultimate near point using the remaining one-third of his accommodation, we draw the dashed line from the upper right corner. This same procedure is repeated for the intermediate as well as for the reading portion.

Returning now to our example of a patient 58 years old, we find that the chart suggests an addition of 2D or 2.25D and that with this addition and the use of a trifocal he has no blind area, seeing perfectly well from about 10½″ to 18″ through his lower, from 18″ to 30″ through



TRIFOCAL DIAGRAM.

Fig. 56

the intermediate, and from there out to infinity through his distance lens.

While trifocals present a definite advantage over bifocals, in cases of additions of 1.75 and more, they should be prescribed only after a cautious evaluation of the visual demands as well as the emotional reactions of the patient.

OCCUPATIONAL LENSES

The Pennsylvania State College of Optometry in the spring of 1943 invited many outstanding men of the Navy, Army and industry for a full-day discussion of the subject, "Vision in Industry." For that occasion I was assigned the task of discussing the papers read. In my discussion I remarked that the ophthalmic lens should not be looked

upon only as a means of correcting visual defects but also as an optical tool to extend the use of our eyes in the same manner as mechanical tools extend the use of our hands. If we accept the time-honored theory that intensive and excessive close work can produce near-sightedness, we must also accept the very simple means of preventing the advent of myopia by using a +1 D lens for such work. In this connection, I particularly think of the disastrous loss of highly-trained human material in the Naval Academy at Annapolis due to the fact that the tests of the third and fourth year men usually show myopia. I have suggested, without success, that the cadets should wear +1 D lenses when settling down to intensive study periods. The same thought, of course, applies to all industrial workers, and practical research along these lines is badly needed.

In general, we can distinguish three main factors in industrial vision, namely:

1. The distance of the object of regard.
2. The location of this object, whether above the primary straight-ahead position or below it.
3. The desired field of view, whether large as in the case of an engineer reading blue prints, or relatively small as in the case of an executive perusing correspondence.

There are, of course, other considerations, namely those of safety. For example, bifocals in the case of a roofer, if used at all, must be of small segments so as to enable him to look past them when climbing.

In general, the regular type of bifocals or trifocals meets all average demands or requirements. Very often, however, the imagination of the refractionist must be used to prescribe successfully for an industrial worker. A plasterer, for instance, needs an extra segment on top of his glasses in order to do a good job on a ceiling without straining his neck. The best way to arrive at a satisfactory solution for industrial prescriptions is to duplicate in your own office, as closely as possible, the conditions of his work.

Of the tests which should be made in determining the addition for presbyopes, the push-in and the push-out method for the determination of the near and far points through the segment as well as the positive and negative relative accommodation tests are possibly the most significant ones. In Figures 57A, 57B and 57C I offer data obtained from these two tests in my own office.

Of course, there is no absolutely rigid, standard addition on account of the spread of the amplitude of accommodation for the same age as well as the influence of the distance correction upon the power

of the segment discussed in a previous chapter. Many years of experience have taught me that the greatest source of discomfort with bifocals is the tendency of the beginning practitioner to prescribe additions which are too high.

As early as 20 years ago, factories in England provided their workers with special working glasses when sustained near vision for fine details was required. Some of this work had also been done in America. When connected with the American Optical Company, I was called upon to investigate visual conditions for workers doing very fine work on spectacle mountings. These workers were supplied with special working glasses, with extremely pleasing results to workers and management alike.

The question is raised at what working distance additional plus power is advisable and this question may be extended to the prismatic power for lenses. It is my opinion that the main contributing factor to fatigue is the sustained accommodative effort. Only at extremely close distances of 10″ or less should additional prismatic power, base-in, be embodied in the working lens. As a preliminary suggestion, I offer the following table.

		D	Base in
Working distance	13″ to 15″	1.00	None
Working distance	9″ to 12″	1.50	1-½D O.D. and O.S.
Working distance	7″ to 9″	2.00	2-¼D O.D. and O.S.

Suggested working lenses for non-presbyopic emmetropes.

SINGLE AND BINOCULAR LOUPES

For clear vision of extremely small objects it is sometimes necessary to resort to the use of magnifiers. The question arises, "What is the magnifying property of such loupes?" A very general consideration of this problem would be to determine the angle suspended by the object without the loupe and that suspended by the image of the object caused by the loupe, Figure 58. This would then give the very general formula of

$$M=\frac{B}{A}=1\div\left[1+\frac{h}{p}\cdot\frac{p-h}{f}\right]$$

Where B is the angle suspended by image

A is that suspended by the object without the loupe

h is distance of the loupe from the nodal point of the eye

p is distance of the object from the eye

f is focal length of the loupe.

This formula is of no value beyond a purely academic interest because one cannot bring the object closer than the accommodative near point.

A much simpler approach to the problem is to compare the retinal image obtained when the object is at the focal plane of the loupe with that obtained when the object is held at a distance of 250 mm. from the naked eye. In this case the object is observed through the loupe

PRESBYOPIA

AGE	Ampl. of Acc. (Mean values) Duane	1.3 Ampl. of Acc.	Addition $\{+ .25\}$ $\{- .25\}$
42	$4.8 \{+ 1.6\}$ $\{-\}$	1.6	$1.00 \{+ .25\}$ $\{-\}$
46	$3.3 \{+ 1.4\}$ $\{-\}$	1.1	$1.37 \{+ .25\}$ $\{-\}$
50	$2.1 \{+\}$ $\{- 0.9\}$	0.7	$1.75 \{+ .25\}$ $\{-\}$
54	$1.4 \{+\}$ $\{- .5\}$	0.5	$2.00 \{+\}$ $\{- .25\}$
58	$1.2 \{+\}$ $\{- .5\}$	0.4	$2.00 \{+\}$ $\{- .25\}$
+26	$1.0 \{+\}$ $\{- .4\}$	0.3	$2.25 \{+\}$ $\{- .25\}$

The presbyopic addition is computed on the assumption that only 1.3 of the total ampl. of acc. is in use when reading at 16" (2.50D.)

Fig. 57A

TABLE FOR SUGGESTED PRESBYOPIC ADDITION.

AGE	ADDITION	P.R.A.	N.R.A.
42	$1.00 \{+\}$ $\{- .25\}$	2.00+	1.25+
46	$1.37 \{+\}$ $\{- .25\}$	1.50+	1.00+
50	$+1.75 \{+\}$ $\{- .25\}$	1.25	1.00
54	$+2.00 \{+\}$ $\{- .25\}$	1.00	1.00
58	$+2.00 \{+\}$ $\{- .25\}$	.75	.75
62+	$+2.25 \{+\}$ $\{- .25\}$	.50+	.50+

These values were determined with the J. N. near point card at 16"; the criterion being the first blur of any of the double lines.

Fig. 57B

TABLE FOR P.R.A. AND N.R.A. IN PRESBYOPIA.

AGE	ADDITION	PUSH UP N.P.'T.	PUSH OUT F.P'T
42	$1.00\left\{\begin{matrix}+\\-\ .25\end{matrix}\right\}$	8.5″+	$32''\left\{\begin{matrix}+\\-\ 2''\end{matrix}\right\}$
46	$1.37\left\{\begin{matrix}+\\-\ .25\end{matrix}\right\}$	9.5″+	$28''\left\{\begin{matrix}+\\-\ 2''\end{matrix}\right\}$
50	$+1.75\left\{\begin{matrix}+\\-\ .25\end{matrix}\right\}$	10.5″	$25''\left\{\begin{matrix}+\\-\ 2''\end{matrix}\right\}$
54	$+2.00\left\{\begin{matrix}+\\-\end{matrix}\right\}$	11″	$22''\left\{\begin{matrix}+\ 1''\\-\end{matrix}\right\}$
58	$+2.00\left\{\begin{matrix}+\ .25\\-\end{matrix}\right\}$	11.25″	$20''\left\{\begin{matrix}+\\-\ 1''\end{matrix}\right\}$
62+	$+2.25\left\{\begin{matrix}+\\-\ .25\end{matrix}\right\}$	11.50″	$18''\left\{\begin{matrix}+\\-\ 1''\end{matrix}\right\}$

These values were determined with J_1 line of the reading card for the binocular blur of any chosen short word.

Fig. 57C
PUSH IN and PUSH OUT BLUR PT'S IN PRESBYOPIA.

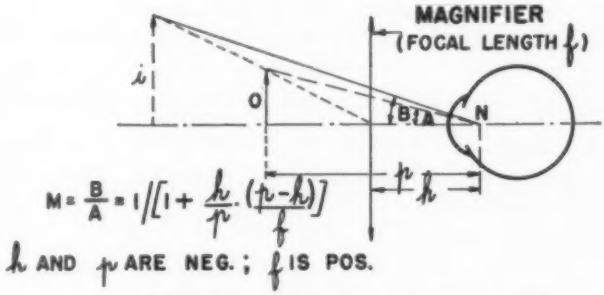


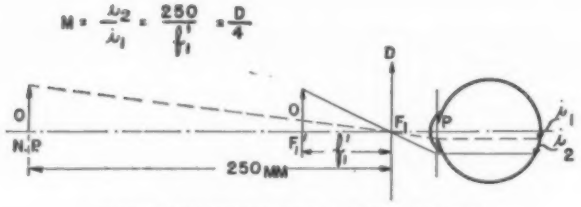
Fig. 58

without the use of any accommodation. Figure 59. This consideration gives the formula:

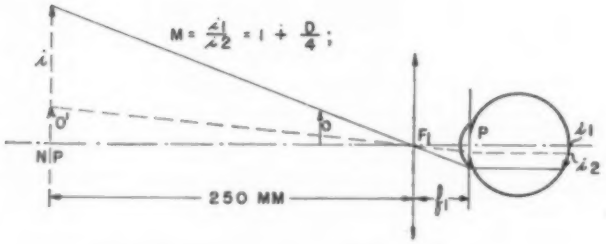
$$M=\frac{D}{4}$$

A still better result is obtained when one uses 4 D of accommodation and brings the object closer to the loupe so that the conjugate image is formed at 250 mm. in front of the loupe. Figure 60. This consideration gives us the following magnification:

$$M=1+\frac{D}{4}$$

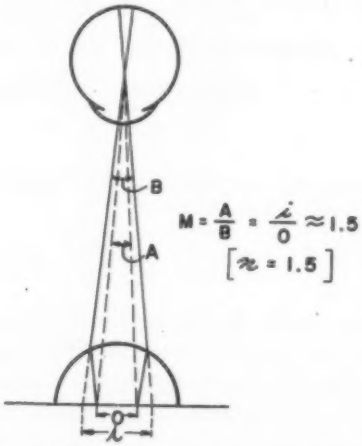


MAGNIFICATION BY A THIN LOUPE
USING NO ACCOMMODATION
Fig. 59

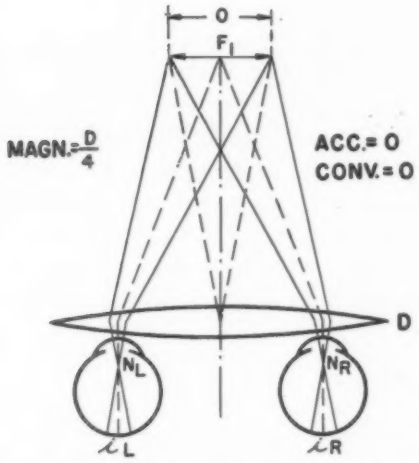


MAGNIFICATION BY A THIN LOUPE
USING 4 D ACCOMMODATION
Fig. 60

There are other single magnifiers. One of these is the so-called aplanatic hemispheric magnifier which consists of a hemispheric lens placed with its flat surface on top of the object of regard. This magnifier has a magnification of only 1.5 but it has the advantage of being without any aberration. Figure 61.



APLANATIC HEMISPHERIC MAGNIFIER
Fig. 61



LARGE BINOCULAR SINGLE LOUPE
(ORTHOPTIC CONDITION)

Fig. 62

Besides the single magnifiers, binocular magnifiers are also used. The simplest one is a spherical loupe large enough to cover both eyes. Figure 62. Assuming no accommodation, this loupe has again the magnification of $\frac{D}{4}$. No matter where the object is held, the convergence in meter angles and the accommodation in diopters are always alike. Such a condition is known as an orthoptic condition.

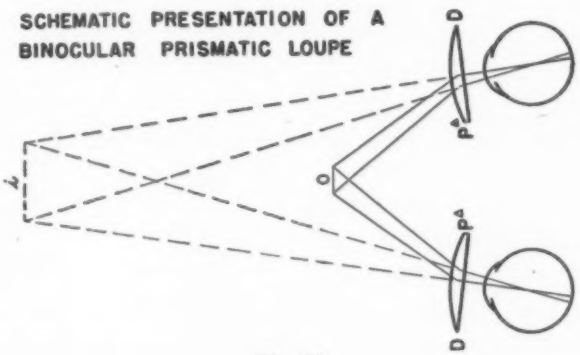


Fig. 63

Finally, there are binocular prismatic loupes. Figure 63. Again the magnification is equivalent to that found with single loupes. The necessary high convergence is reduced by the application of prism power, base-in, on each eye.

TELESCOPIC SYSTEMS

Sometimes single loupes do not give sufficient magnification. In such cases the use of telescopic systems is indicated.

We distinguish two telescopic systems, namely, the astronomical system consisting of two positive lenses separated by the sum of their focal distances, and the so-called terrestrial system with the objective, a positive lens, and the ocular, a negative lens, again separated by the algebraic sum of their focal distances. The terrestrial system is the one used in everyday life because it gives upright images while the astronomical system would invert the image. Figure 64.

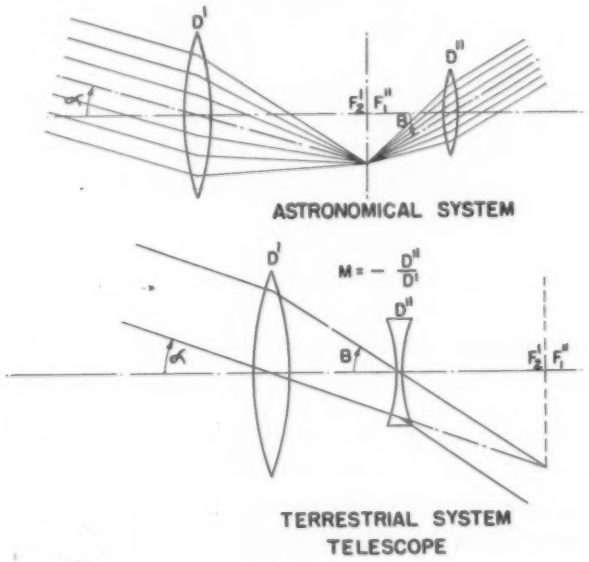


Fig. 64

The magnification of the telescopic system is expressed by:

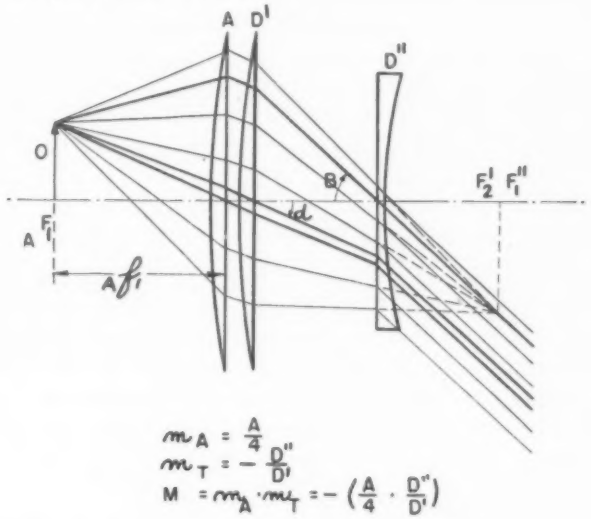
$$M = -\frac{D''}{D'}$$

Where D'' is the dioptric power of the ocular
D' that of the objective.

When telescopic loupes are used to view close objects, an auxiliary lens is placed over the objective which converts the rays entering the telescopic system into a bundle of parallel rays. Figure 65. It is obvious that the focal length of the auxiliary lens must equal the distance from the object to the objective. The magnification of the system is built up of two factors—that produced by the auxiliary lens and that produced by the telescopic system so that the total magnification equals

$$M = -\left[\frac{A}{4} \cdot \frac{D''}{D'}\right]$$

Where A is the power of the auxiliary lens
D″ is the power of the ocular
D′ is the power of the objective.



$$m_A = \frac{A}{4}$$
$$m_T = -\frac{D''}{D'}$$
$$M = m_A \cdot m_T = -\left(\frac{A}{4} \cdot \frac{D''}{D'}\right)$$

TELESCOPE WITH AUXILIARY LENS

Fig. 65

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FURTHER STUDY OF EFFECTS INDUCED BY ANISOMETROPIC CORRECTIONS*§

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INTRODUCTION

It is known that the anisometrope develops a capacity for compensating vertical prismatic inequalities at the straightforward and reading positions.[1] Due to this fact, very small or no vertical phorias are demonstrable at these positions, even though considerable vertical prismatic inequalities are encountered. Furthermore, it has been shown that as the phorias become adjusted to the prismatic inequality at the two positions, the midpoint of the duction range shifts accordingly.

The present investigation was undertaken to supplement the available experimental data concerning compensations which are made to the prismatic inequalities by patients with anisometropia. Of particular concern has been the variation of the compensation for different directions of fixation.

INSTRUMENTS AND PROCEDURE

In order to measure a vertical phoria at different directions of gaze and to correlate it with the prismatic imbalance encountered, certain requirements with regard to instrumentation and experimental procedure need to be considered. For example, when anisometropic spectacles are worn and fixation is maintained on a point in the visual field, a movement of the head up or down alters the prismatic imbalance encountered. As a consequence, it is necessary to control the position of the head while such measurements are made.

The fact that the poles of spectacle lenses vary in position likewise has to be considered. Oftentimes they are displaced vertically to minimize the prismatic imbalance for a given position of the lines of sight. Due to this factor, it is necessary to determine the relative positions of the poles of the spectacle lenses with respect to the points on the lenses penetrated by the lines of sight for a given direction of gaze.

Another important requirement which must be met in the measure-

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§Author's abstract, page 437.

ment of a vertical phoria is that fusional stimuli be provided to maintain horizontal binocular fusion in the absence of any stimuli which might induce a vertical fusional movement.[2, 3] If horizontal binocular fusion is not maintained during the measurement of a vertical phoria, the finding is only a presumptive indication of the demands placed upon the fusion reflex in the normal use of the eyes.

In the measurement of the compensation to prismatic imbalances, two different approaches can be employed. In the one, the vertical phoria is determined as the lines of sight are made to pass through points in the periphery of the spectacle lenses. This is accomplished by fixing the position of the face plane and changing the direction of fixation by movements of the eyes. By the use of this approach, prismatic imbalances which vary in amount as well as direction are encountered for different directions of gaze. In the other approach, the vertical phoria is determined for different directions of gaze in the absence of peripheral prismatic effects due to the correction lenses for the anisometropia.

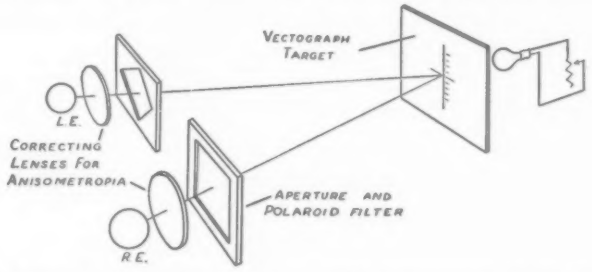

Fig. 1. Schematic illustration of the essential components of the instrument employed to measure vertical phorias at various elevations of the eyes. Peripheral prismatic imbalances due to the correcting anisometropic lenses were not encountered since the lenses were mounted to and rotated with the instrument.

In order to measure a vertical phoria by means of either approach, the instrument schematically illustrated in Figures 1 and 2 was employed. The dissociation of the stimuli presented to the eyes was accomplished by means of polarized targets and analyzing polaroid filters. To minimize peripheral fusional stimuli, dissimilar apertures were used before the two eyes. These apertures were at a distance of 0.08 meters from the corneas and consequently their retinal images were considerably blurred.

In order to correct an anisometropia, either the spectacle lenses mounted to the head or trial lenses mounted in cells and attached to the instrument could be employed. With the former method peripheral prismatic imbalances were encountered. Lenses required for changes in distances of fixation were mounted in the cells of the instrument. The lens cells, aperture and polaroid filter for use before each eye were fixed

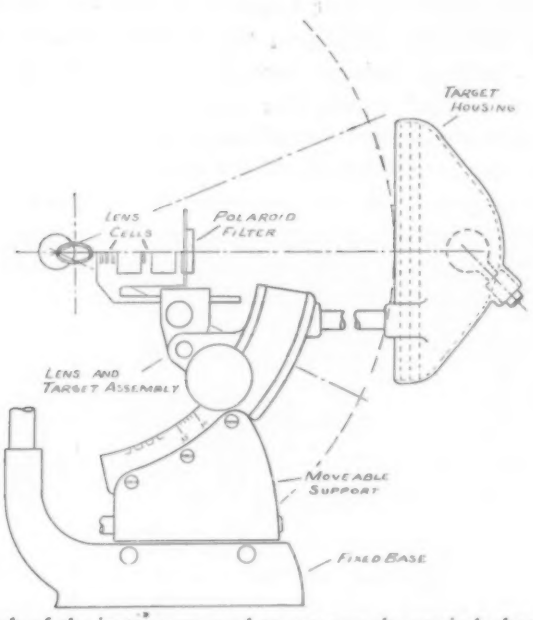

Fig. 2. Sketch of the instrument used to measure the vertical phorias.

to a common mount. The mounts for the two eyes could be simultaneously adjusted to any interpupillary distance as well as for fixation distances of 0.40 and 3.00 meters.

There are four essential mechanical portions of the instrument: namely, a fixed base, a moveable support for the lens and target assembly, the lens and target assembly, and devices to fix the position of the head. All of these parts with the exception of the forehead rest and chin support are shown in Figure 2. The moveable support could be adjusted laterally, or fore and aft in order to set the target at a fixed distance of 0.40 meters from the cornea. An aligning device for each eye permitted this distance to be set to an accuracy of less than 0.001 meter. By means of the curved rack on the moveable support and gears mounted to the lens and target assembly, the target could be set at any desired elevation of the eyes.

An instrument called a topometer was employed to determine the relative positions of the poles of the spectacle lenses when they were worn.[4] This instrument has been fully described in the literature and consequently a detailed description of it is not warranted in this report. By the use of the topometer, it was possible to accurately determine the position of the poles of the spectacle lenses relative to the straight-forward position of the lines of sight. Since the forehead rest and chin cup of the instrument were in vertical alignment, the measurements were

made with the face plane in a vertical position. The use of the topometer likewise enabled an accurate measure of the tilt of the lenses before the eyes as well as their distances from the corneas.

RESULTS

The vertical phorias of a number of patients with anisometropia were measured at different elevations of the eyes and at distances of fixation of 0.40 and 3.00 meters. The phorias were measured while correcting spectacle lenses were worn as well as when the anisometropia was corrected by means of trial case lenses mounted to the instrument.

The results varied from one individual to another and consequently cannot be satisfactorily discussed as a group. As a consequence, only the results of two patients which specifically illustrate several important findings will be discussed.

It was pointed out earlier that one of the objects of this investigation was the study of the compensation to prismatic imbalances at different elevations of the eyes. Evidence which indicates that the compensation is variable and continuous for different elevations of the eyes are the results of one patient which are graphically given in Figure 3.

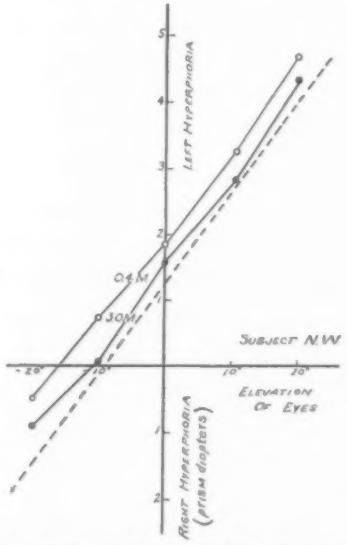

Fig. 3. Graphical plot of the vertical phorias of a patient measured at different elevations of the eyes in the absence of any prismatic imbalance due to the spectacles. The broken curve represents the phorias expected on the basis of *complete* compensation to the prismatic imbalances of the spectacle lenses. The distances of fixation at which the phorias were measured are indicated in the curves.

In this figure, the vertical phoria expected on the basis of complete compensation to the prismatic imbalance of the spectacles at dif-

ferent elevations of the eyes is represented by the broken curve. The values for this curve were computed from measurements made with the topometer. The refractive correction and visual acuities of the patient were:

Distance Correction
O. D. —8.00 D. sph.⊂ —1.50 D. cyl. axis 95. V. A.=20/25.
O. S. —5.25 D. sph.⊂ —1.00 D. cyl. axis 90. V. A.=20/25.
Visual acuity, O. U.=20/25.

The continuous curves in Figure 3 are a plot of the vertical phorias at different elevations for fixation distances of 0.40 and 3.00 meters. The correcting lenses for the anisometropia were mounted to the instrument and thus no vertical prismatic imbalances due to these lenses were encountered regardless of the elevation of the lines of sight. It is noteworthy that the vertical phorias both at 0.40 and 3.00 meters varied with the elevation and was proportional to the prismatic imbalance normally encountered with the spectacle lenses.

These results indicated that if the vertical phorias were measured through the spectacle lenses at different elevations, relatively small phorias would be found even though considerable prismatic imbalance would

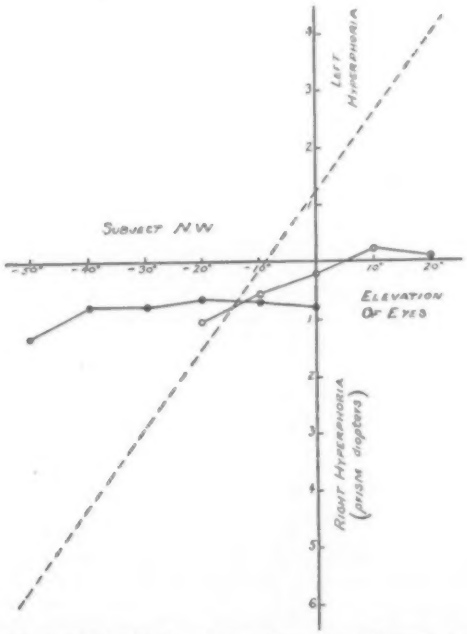

Fig. 4. Plot of the vertical phoria of a patient for different elevations of the eyes. The phorias were measured through the spectacle lenses. The broken curve represents the expected phorias in *the absence* of compensation to the prismatic imbalances of the spectacle lenses.

be encountered. The results plotted in Figure 4 clearly illustrate that this is actually the case.*

Although the vertical phorias of a patient at a given elevation usually do not vary even for relatively long periods of observation, occasionally one is encountered whose phorias vary significantly within a very short time. The results graphically given in Figure 5 illustrate

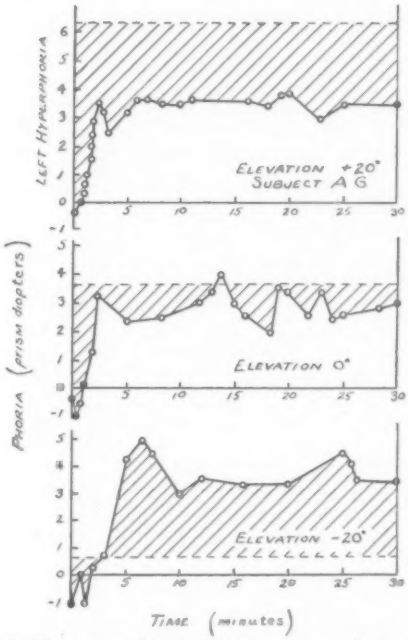

Fig. 5. Data which illustrates the variation of a vertical phoria with time of observation of the phoria target. The measurements were made at different elevations of the eyes through spectacle lenses while the face plane was kept vertical. The cross-hatched area indicates the extent of compensation.

such a variation. In this figure the broken horizontal line indicates the expected phorias in the absence of compensation to the prismatic imbalances of the spectacle lenses for the elevation at which the measurements were made. The irregular curves are a plot of the phoria measurements. During all of the experiments the spectacle lenses were worn. Consequently, if complete compensation had been made to the prismatic imbalances, no vertical phorias would have been measured. The magnitude of a phoria, thus is a measure of the extent of compensation.

The phoria measurements presented in Figures 5 were made at a

*The data illustrated by the curve connecting the solid points was obtained by the use of an instrument called the phoriometer. This instrument has been fully described in the literature (cf. Bibliography ref. 3).

fixation distance of 3.0 meters. The refractive correction and visual acuities of the patient were as follows:

O. D. —4.00 D. sph. V. A.=20/20.

O. S. —0.25 D. sph. ⌒ —0.50 D. cyl. axis 180. V. A.=20/15.

Visual acuity, O. U.=20/15.

From an inspection of Figure 5, it is apparent that the compensation of the eyes to the prismatic imbalances can be classified into two parts. One would be the immediate compensation as the elevation of the eyes was altered; the second is the compensation remaining after a period of observation of the phoria targets and thus vertical dissociation of the eyes. When the average compensation for the first minute of observation was computed and these results compared with the expected phorias on the basis of complete compensation at the different eleva-

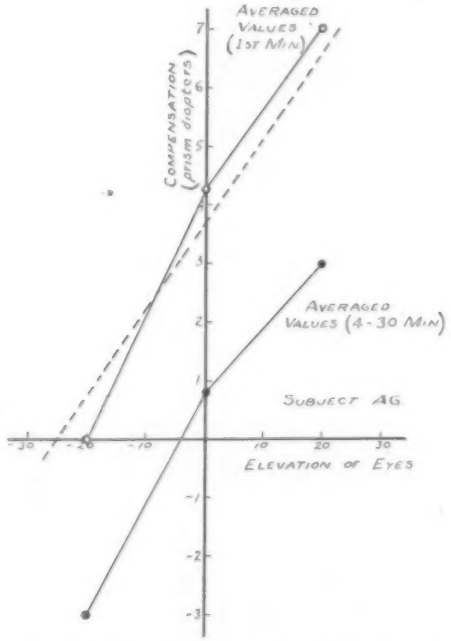

Fig. 6. Replot of the data given in Figure 5. The broken curve represents the expected phorias for complete compensation to the prismatic imbalances at the different elevations. The two solid curves are the average values of the compensation during the first minute of observation of the phoria targets and during the period of four to thirty minutes.

tions, the results illustrated in Figure 6 were obtained. Also shown in Figure 6, are average values of the compensation for the period of observation extending from four to thirty minutes. These findings suggest that both the fusional movements of the eyes as well as the variable

compensation to the prismatic imbalance were utilized in the maintenance of single binocular vision while the spectacles were worn.[5, 6] When the demand upon the fusional reflex was removed, the eyes returned to the fusion-free position. However, even in this position the variable compensation to the prismatic imbalance was present.

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Author's Abstract. For this study, an instrument was employed with which a vertical phoria could be accurately measured at different elevations of gaze. If the phorias were determined with spectacle lenses, peripheral prismatic imbalances were encountered by anisometropic patients. However, if trial case lenses mounted to the instrument were used for the correction of an ametropia, no prismatic imbalances were encountered regardless of the elevation of gaze.

By the use of these two methods, a careful determination and analysis was made of the vertical phorias of three subjects with anisometropia at different elevations above and below the straight forward position of the eyes.

The difference between a measured phoria and the prismatic imbalance is called compensation to prismatic imbalance. It was found that the compensation varies with the direction of gaze and is roughly equal to the prismatic imbalance. The findings for one subject suggest that both the fusional movements of the eyes as well as the variable compensation to the prismatic imbalance were utilized in the maintenance of single binocular vision while spectacles were worn.—V. J. Ellerbrock.

ABSTRACT

THE SIGNIFICANCE OF CLINICAL PSYCHOLOGY IN THE OPTOMETRIC CURRICULUM. L. Wekstein. Bulletin of the Massachusetts Society of Optometrists. 28. 6. 111-114. 1948.

The author finds that both medicine and optometry have, to a large extent, given psychology the "cold shoulder" and that most practitioners in these groups practice as though psychology does not exist. He deplores this attitude and points out that in optometry our pseudo-myopias and some forms of amblyopia are correctible by means of psychological therapies. He urges more psychological training in optometric colleges.

C. C. K.

INVESTIGATION OF THE VARIATION AND THE CORRELATION OF THE OPTICAL ELEMENTS OF HUMAN EYES*§

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PART V — CHAPTER III

2. THE VARIATION OF THE OPTICAL ELEMENTS RELATED TO THE REFRACTIVE ERROR. BETWEEN DEPTH OF THE ANTERIOR CHAMBER AND REFRACTIVE ERROR (Table 20), we find a moderate negative correlation ($r_{Ad} = -0.34 \pm 0.028$). Therefore the depth of the anterior chamber diminishes as we go from myopia toward hyperopia. The correlation table shows, however, that the regression is non-linear. The maximum depth is attained in myopia of moderate amount (—5.00 to —6.00 D.), after which it again decreases. The number of cases of high myopia covered by this investigation is of course too small to warrant a definite conclusion. Yet we might consider the greater depth as a compensating effect of the basic cause of the myopia since an increase in the depth works to diminish the myopia when all other factors are held constant. Correspondingly the depth appears to be minimal at 2 to 3 D. of hyperopia; there appears to be no further diminution from this point on, but contrariwise a definite increase appears, which can possibly be explained by reasoning analagous to that used in myopia. The regression can best be described as an S-shaped third degree curve. It is noteworthy that the variation of the group between 0 and +1 is almost equal to that of the entire sample. For this group we obtained an average value of 3.66 ± 0.011 mm., which is not notably different from that of the total group, and a σ of ± 0.254 ± 0.008 mm. The difference between this σ and that of the entire sample amounts to 0.033 ± 0.010 and is really not significant.

As previously mentioned, it has been known for some time that the anterior chamber is deeper in myopia and shallower in hyperopia than it is in emmetropia. As yet a detailed study of the correlation has not been undertaken. Rosengren's material is not adaptable for treatment

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*UPSALA 1946. Appelbergs Boktryckeri A.-B.

§The fifth of six chapters. The final chapter will appear in the October issue.

from this viewpoint. On the other hand, a crude survey can be obtained from Raeder's cases—Aged 20 to 40—of about 104 subjects. The correlation coefficient is —0.35 ± 0.086. Although the sample is too small to permit a definite conclusion, the assumption of a parabolic regression curve appears correct.

THE AXIAL LENGTH exhibits a distinct correlation with refraction as shown in Table 21. The correlation coefficient is $r_{Ab_1} = -0.76 \pm 0.014$. Since neither of the variables is normally distributed, a correlation elipse cannot depict correctly the correlation.

Because of the higher coefficient of correlation, the standard deviation within a single refractive error step-interval is rather insignificant. Accordingly, we see that for the central group the mean is 23.85 ±0.030 mm. and the standard deviation is ±0.684 ±0.021 mm., a substantially lower σ than that of the entire group. (The difference is 0.41 ±0.033.)

For this central group, a distribution of the axial length was obtained which fully agrees with the normal distribution curve, as shown in Figure 14. $\frac{\chi^2}{m}$ is 1.513 (m = 4), as against a maximum allowed value of 4.063.

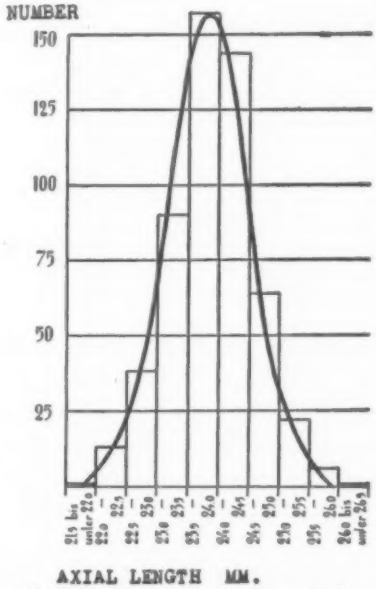

Fig. 14. Frequency Distribution of Axial Length for the Central Group (0 to +1 D).

As is shown in Table 21, no myopic eye was less than 22 mm. in length and no emmetropic or hyperopic eye exceeded 26.5 mm.

Furthermore, it should be observed that all eyes of over 8 D. of ametropia have axial lengths which fall outside the range in which emmetropic eyes are found. Such eyes can be characterized as axial ametropias in accordance with Tron's definition.

As mentioned, Schnabel and Herrnheiser (Table 3) found a variation between 22.0 and 25.0 mm. for the axial length of emmetropic eyes. This value is somewhat smaller than that found here.

Tron found a correlation of 0.647 between axial length and refractive error which is of corresponding magnitude with that which I have found; that it is somewhat smaller may be explained by the relatively large error in the computation of the axial length in Tron's material.

THE CORNEAL REFRACTING POWER showed a weak negative correlation with refractive error (Table 22); $r_{AD_1} = -0.18 \pm 0.031$. Correspondingly we find that the entire range contains cases from the central group of refractive error (0 to 1 D.). For this group we obtain $M = 42.67 \pm 0.059$ D. and $\sigma = \pm 1.344 \pm 0.041$, neither of which definitely departs from the corresponding values for the entire sample.

Czellitzer's table on the correlation between refractive error and corneal refracting power is not carried out statistically, but observation indicates a weak negative correlation. Steiger's material appears to show a weak correlation of the same type. Wibaut (c) has made such a computation on patients of different age groups. For 1,232 adult males he found $r = +0.036 \pm 0.028$; which is not a particularly detectable correlation. Wibaut points out that his material is not representative; 23 per cent were myopes and 32.5 per cent were hyperopes over +1 D. For other age groups he obtained a coefficient of correlation of about +0.2. Since Wibaut continued the particularly unfortunate designation of Straub where E + 3 is used to indicate a myopia of —3 D, he obtained a positive value for what in truth is a negative correlation. Therefore, his value in no way stands opposed to mine.

BETWEEN REFRACTING POWER OF THE LENS and refractive error (Table 23), no correlation can be established. Here $r_{AD_2} = 0.00 \pm 0.031$. We get a large variation of the lenticular refracting power within the group 0 to +1 D. ($\sigma = \pm 1.38 \pm 0.042$ D., which is virtually the same as that for the entire sample.)

Tron gave no value for the correlation between refractive error and the refracting power of the lens. My computation of his data gave the value of $+0.74 \pm 0.071$. Accordingly this correlation is not established and therefore agrees with the result stated above.

Finally we come to the question of the variation of the total refracting power in relation to the refractive error (Table 24). The question is complicated by the computation of total refracting power as a function of the refractive error. However, in this case we have computed the true value of the total refracting power apart from experimental error; and possible objections to the correlation for this reason have not been considered.

We obtain a very weak negative correlation $r = -0.10 \pm 0.031$, which was to be expected. In accordance with the weakness of the correlation, the variation of the central refractive error group was equally as large as that of the entire sample. For this group, M =

TABLE 22.

Correlation Between Principal Point Refraction and Refracting Power of the Cornea

Refracting Power of the Cornea in Dptr.	Principal Point Refraction in Dptr.	38.5 to <39.0	39.0 to 39.5	39.5 to 40.0	40.0 to 40.5	40.5 to 41.0	41.0 to 41.5	41.5 to 42.0	42.0 to 42.5	42.5 to 43.0	43.0 to 43.5	43.5 to 44.0	44.0 to 44.5	44.5 to 45.0	45.0 to 45.5	45.5 to 46.0	46.0 to 46.5	46.5 to 47.0	47.0 to 47.5	47.5 to 48.0	48.0 to <48.5	Total
+10.0 to <+11.0					1																	3
+9.0 to <+10.0					1																	1
+8.0 to <+9.0				1					2													3
+7.0 to <+8.0																1						3
+6.0 to <+7.0					1				1		1											5
+5.0 to <+6.0					1		1		1	2	1	1		2	1							8
+4.0 to <+5.0							1	2			1		1									8
+3.0 to <+4.0				1		1			4		1	1	1	1			1					8
+2.0 to <+3.0					1		1	4	5	1	1	1	1		1	3						18
+1.0 to <+2.0					4	4	3	12	16	25	16	21	15	5	8	2	1					132
± 0 to <+1.0		4	3	6	16		26	42	53	89	84	79	53	36	24	7	7	5	1	1		536
−1.0 to <0					3		3	6	10	13	13	21	18	9	9	4	4	1		1		115
−2.0 to <−1.0					1			3	2	3	3	12	8	7	4	3	1	3	1			51
−3.0 to <−2.0					1		2	2	1	3	4	7	5	2	2	3	1				1	34
−4.0 to <−3.0		1						1	1	3	4	3	5	2	1	1	2			1		25
−5.0 to <−4.0							1	1	1	3	3	2	4	1	1	1	2					20
−6.0 to <−5.0									1		2		1	1	3			2				10
−7.0 to <−6.0					1			1			3		1	1								5
−8.0 to <−7.0										1	2						1					5
−9.0 to <−8.0									1			1	1									3
−10.0 to <−9.0									3						1							4
−11.0 to <−10.0							1								1							1
−12.0 to <−11.0									1													1
−13.0 to <−12.0																						0
−14.0 to <−13.0															1							1
Total		5	4	11	31		38	72	89	157	142	151	115	67	56	24	20	12	3	1	1	1000

TABLE 23.

Correlation Between Principal Point Refraction and Refracting Power of the Lens

Refracting Power of the Lens in Dptr.	Principal Point Refraction in Dptr.	12.0 to <12.5	12.5 to 13.0	13.0 to 13.5	13.5 to 14.0	14.0 to 14.5	14.5 to 15.0	15.0 to 15.5	15.5 to 16.0	16.0 to 16.5	16.5 to 17.0	17.0 to 17.5	17.5 to 18.0	18.0 to 18.5	18.5 to 19.0	19.0 to 19.5	19.5 to 20.0	20.0 to 20.5	20.5 to 21.0	21.0 to 21.5	21.5 to 22.0	22.0 to 22.5	22.5 to 23.0	23.0 to 23.5	23.5 to 24.0	24.0 to 24.5	24.5 to <25.0	Total
+10.0 to <+11.0								1		1			1															3
+9.0 to <+10.0													1															1
+8.0 to <+9.0										1	1																	3
+7.0 to <+8.0		1			1					1	1	1																3
+6.0 to <+7.0								2			1																	5
+5.0 to <+6.0										1	2			1														8
+4.0 to <+5.0					1					1	1	1		3														8
+3.0 to <+4.0						2				1	1		1	2	2		1											8
+2.0 to <+3.0									2	3		3	2	2	1	3	1			1								18
+1.0 to <+2.0			1				3	9	7	11	9	23	21	20	14	7	1	4	1		1							132
0 to <+1.0				4	3	14	15	40	58	68	93	78	51	39	28	21	16	4	3	1								536
+1.0 to <0				3		2	7	14	11	17	16	14	9	10	4	5	2	1										115
−2.0 to <−1.0			1	2	2	1	3	6	4	6	9	7	3	3	2	1		1										51
−3.0 to <−2.0				1			3	4	3	4	6	5	5	2			1											34
−4.0 to <−3.0								4	3	1	3	5	6	1			1											25
−5.0 to <−4.0					1	2		2	1	4	4	2	2		1								1					20
−6.0 to <−5.0			1		1	1	1		1	2	1			1	1													10
−7.0 to <−6.0										1		2	1	1														5
−8.0 to <−7.0							1		1	1			2															5
−9.0 to <−8.0								1				1					1											3
−10.0 to <−9.0								1						1	1	1												4
−11.0 to <−10.0													1															1
−12.0 to <−11.0												1																1
−13.0 to <−12.0																												0
−14.0 to <−13.0																												1
Total		1	0	3	11	10	23	42	83	102	119	161	140	103	79	49	32	25	7	4	3	1	1	0	0	0	1	1000

TABLE 24.

Correlation Between Principal Point Refraction and Total Refracting Power of the Eye

| Principal Point Refraction in Dptr. | Total Refracting Power of the Eye in Dptr. | | |

58.05 D ± 0.074 D and $\sigma = \pm$ 1.72 ± 0.053 D were obtained, which do not depart effectively from those values obtained for the whole group. Consequently one cannot speak of a "refractive ametropia," because the total refracting power of the ametropic eyes does not depart from that of normal eyes. (Naturally, purely pathologic cases of microphthalmus and the like are excepted.)

Tron found a coefficient of correlation on his material of 0.068[36] between total refracting power and refractive error which is not particularly significant because a mean error of ± 0.07 can be computed for the coefficient.

3. THE CORRELATIONS BETWEEN THE DIOPTRIC ELEMENTS (Tables 25, 26, and 27). Since the total refracting power is a direct function of the refracting powers of the cornea and lens, we know *a priori* that strong correlations between the first-named value and both of the latter must exist. Nevertheless, it is interesting to establish the relative strengths of these correlations.

We arrive at the following coefficients:

$$r_{DD_1} = +0.66 \pm 0.018$$
$$r_{DD_2} = +0.70 \pm 0.016$$
$$r_{D_1D_2} = -0.12 \pm 0.031$$

It is easy to understand that the first two coefficients are virtually identical since the expression for D. is symmetrical with respect to both of these variables.

Between the refracting powers of the cornea and lens, there exists a weak negative correlation as shown by the coefficient above.

We can use these coefficients to prove positively the connection between the standard deviation of the total refracting power and those of the partial refracting powers.

When we write the expression for total refracting power in the form

$$D = D_1 + D_2 \left(1 - \frac{d}{n} D_1\right) \quad \ldots\ldots (12)$$

we can, with a slight approximation put the last factor equal to 0.887 (it varies between 0.884 and 0.918 with a mean of 0.887) and obtain

$$D = D_1 + 0.887\ D_2 \quad \ldots\ldots (12a)$$

Computing σD by using the standard deviations of D_1 and D_2[37], we obtain the value $\sigma^D = \pm$ 1.75. Since a value of ± 1.78 ± 0.04 was found by direct computation, this indirectly obtained value lends full

36 Tron gave no sign for this value but to judge from the correlation table, it is negative.

37 According to the formula

$$\sigma_D^2 = \sigma_{D_1}^2 + 0.786\,\sigma_{D_2}^2 - 2(0.12)\ (0.887)\ \sigma_{D_1} \cdot \sigma_{D_2} \quad \ldots\ldots (13)$$

TABLE 25.

Correlation Between Total Refracting Power of the Eye and Refracting Power of the Cornea.

Total Refracting Power of the Eye in Dptr.	Refracting Power of the Cornea in Dptr.	38.5 to <39.0	39.0 to 39.5	39.5 to 40.0	40.0 to 40.5	40.5 to 41.0	41.0 to 41.5	41.5 to 42.0	42.0 to 42.5	42.5 to 43.0	43.0 to 43.5	43.5 to 44.0	44.0 to 44.5	44.5 to 45.0	45.0 to 45.5	45.5 to 46.0	46.0 to 46.5	46.5 to 47.0	47.0 to 47.5	47.5 to 48.0	48.0 to <48.5	Total
63.5 to <64.0	63.5 to 64.0																				1	3
63.0 to 63.5	62.5 to 63.0						1			1		1		1	2							4
62.0 to 62.5	61.5 to 62.0									1	2			2								13
61.5 to 61.0	60.5 to 61.0								1	2	8	9	2	8	4	4	1		1			39
60.0 to 60.5	59.5 to 60.0					1	1	3	8	3	6	11	7	5	4	1	2					48
59.5 to 60.0	59.0 to 59.5					1		3	4	7	13	8	13	3	2	3	2					60
59.0 to 59.5	58.5 to 59.0					1	5	3	11	18	12	19	10	7	3	3	1					88
58.5 to 59.0	58.0 to 58.5				1	2	4	11	17	12	21	19	9	5	3		2					101
58.0 to 58.5	57.5 to 58.0				1	3	8	12	24	25	26	22	6	5	2		1					122
57.5 to 58.0	57.0 to 57.5			1	2	4	10	22	21	18	22	10	5	3			1					107
57.0 to 57.5	56.5 to 57.0				3	9	14	15	23	21	17	8	5	2	2							116
56.0 to 56.5	55.5 to 56.0	2	1		4	6	11	8	11	17	14	1	2	1								99
55.5 to 56.0	55.0 to 55.5		1	2	3	3	9	2	11	7	4	1										58
55.0 to 55.5	54.5 to 55.0	1		2	2	3	6	4	4	4	1	1										38
54.5 to 55.0	54.0 to 54.5					3	2	4	1	2	3	1										30
54.0 to 54.5	53.5 to 54.0		1		1	1				1	1											18
53.5 to 53.5	53.0 to 53.5	1				2	4	1														6
53.0 to 53.0	52.5 to 53.0																					7
52.5 to <52.5	52.0 to <52.5				1																	3
Total		5	4	11	31	38	72	89	157	142	151	115	67	56	24	20	12	3	1	1	1	0
																						1
																						1000

TABLE 26.

Correlation Between Total Refracting Power of the Eye and Refracting Power of the Lens

Refracting Power of the Lens in Dptr.	Total Refracting Power of the Eye in Dptr.	12.0 to <12.5	12.5 to 13.0	13.0 to 13.5	13.5 to 14.0	14.0 to 14.5	14.5 to 15.0	15.0 to 15.5	15.5 to 16.0	16.0 to 16.5	16.5 to 17.0	17.0 to 17.5	17.5 to 18.0	18.0 to 18.5	18.5 to 19.0	19.0 to 19.5	19.5 to 20.0	20.0 to 20.5	20.5 to 21.0	21.0 to 21.5	21.5 to 22.0	22.0 to 22.5	22.5 to 23.0	23.0 to 23.5	23.5 to 24.0	24.0 to 24.5	24.5 to <25.0	Total
63.5 to <64.0																			2			1						3
63.0 to 63.5													1				2			1								4
62.5 to 63.0																		1	1								1	4
62.0 to 62.5												1	2				3	3	2	1	1							13
61.5 to 62.0													1	3,		5	1	2	1									13
61.0 to 61.5										1	1	1	3	4	6	4	1	3		2								22
60.5 to 61.0								.	1	1	1	3	4	7	5	8	5	4										39
60.0 to 60.5										2	4	5	6	9	11	4	4	6			1							48
59.5 to 60.0								1	1	2	4	5	14	7	10	8	4	2	1		1							60
59.0 to 59.5							1	2	3	5	5	13	15	18	13	7	5	1										88
58.5 to 59.0							1	2	3	5	10	26	16	13	14	4	4	2										101
58.0 to 58.5						1		1	9	14	16	27	24	18	6	3	1	1										122
57.5 to 58.0					1			4	4	16	19	24	15	13	6	3												107
57.0 to 57.5						1	2	4	5	14	14	23	25	14	7	4	2	1										116
56.5 to 57.0						2	1	2	4	18	18	20	16	14	1	3												99
56.0 to 56.5								3	4	11	11	7	10	6	5		1											58
55.5 to 56.0							2		6	7	5	6	3	3	1	1												38
55.0 to 55.5					1	3	3	3	5	6	3	3	1	1	1	1												30
54.5 to 55.0		1			1	1	1	2	3	4	2	1	1	1														18
54.0 to 54.5								1	2		2	1																6
53.5 to 54.0									3	2		2																7
53.0 to 53.5								2			1																	3
52.5 to 53.0																												0
52.0 to <52.5								1																				1
Total		1	0	3	11	10	23	42	83	102	119	161	140	103	79	49	32	25	7	4	3	1	1	0	0	0	1	1000

TABLE 27.
Correlation Between Refracting Power of the Lens and Refracting Power of the Cornea

Refracting Power of the Lens in Dptr.	Refracting Power of the Cornea in Dptr.	38.5 to <39.0	39.0 to 39.5	39.5 to 40.0	40.0 to 40.5	40.5 to 41.0	41.0 to 41.5	41.5 to 42.0	42.0 to 42.5	42.5 to 43.0	43.0 to 43.5	43.5 to 44.0	44.0 to 44.5	44.5 to 45.0	45.0 to 45.5	45.5 to 46.0	46.0 to 46.5	46.5 to 47.0	47.0 to 47.5	47.5 to 48.0	48.0 to <48.5	Total
24.5 to <25.0	21.5 to 22.0					1																1
24.0 to 24.5	21.0 to 21.5																					0
23.5 to 24.0	20.5 to 21.0																					0
23.0 to 23.5	20.0 to 20.5					1	1				1											3
22.5 to 23.0	19.5 to 20.0																					0
22.0 to 22.5	19.0 to 19.5																					0
21.5 to 22.0	18.5 to 19.0										1											1
21.0 to 21.5	18.0 to 18.5										1											1
20.5 to 21.0	17.5 to 18.0																					0
20.0 to 20.5	17.0 to 17.5																					0
19.5 to 20.0	16.5 to 17.0																					0
19.0 to 19.5	16.0 to 16.5																					0
18.5 to 19.0	15.5 to 16.0																					0
18.0 to 18.5	15.0 to 15.5																					0
17.5 to 18.0	14.5 to 15.0																					0
17.0 to 17.5	14.0 to 14.5																					0
16.5 to 17.0	13.5 to 14.0																					0
16.0 to 16.5	13.0 to 13.5																					0
15.5 to 16.0	12.5 to 13.0																					0
15.0 to 15.5	12.0 to <12.5																					0
14.5 to 15.0																						0
14.0 to 14.5																						0
13.5 to 14.0																						0
13.0 to 13.5																						0
12.5 to 13.0																						0
12.0 to <12.5																						0
Total		5	4	11	31	38	72	89	157	142	151	115	67	56	24	20	12	3	1	1	1	1000

TABLE 28.

Correlation Between Total Refracting Power of the Eye and Axial Length

| Axial Length in mm. | Total Refracting Power of the Eye in Dptr. | | |

agreement and supports the value set forth.

4. THE CORRELATION OF TOTAL REFRACTING POWER AND AXIAL LENGTH. (Table 28) As a finale in the study of correlation of the ocular elements we now consider the one between total refracting power and axial length; namely between the power of the dioptric system and the position of the receiving surface.

As stated previously, it is better to use a reciprocal value of the axial length[38], in order that the true relationship will be manifest.

We arrive at a correlation coefficient of $+0.61 \pm 0.020$. The covariation is depicted by the correlation ellipse of Figure 15. It should be noted that the ellipse can only give an approximate idea because the axial length, as well as its reciprocal value does not approach a normal distribution.

The strength of this correlation is really worthy of note, because the correlation between corneal refracting power and axial convergence is significantly weaker. (The correlation between corneal radius and axial length is approximately the same, r being about $+0.30$). The correlation between axial length and refracting power of the lens is also weak ($r = -0.36 \pm 0.028$). Therefore, the optical elements combine in a compensatory manner. It can be seen that the depth of the chamber is effective in this direction.

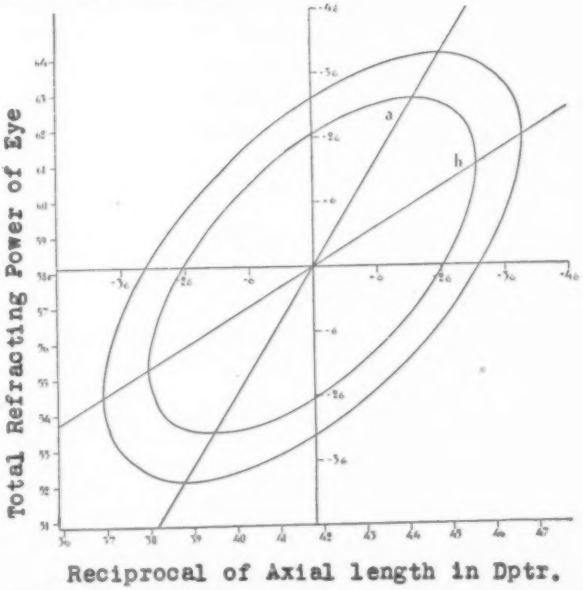

Fig. 15. Correlation Ellipse for the Vergence Value of the Axial Length and Total Refracting Power.

38 $B_1 = n/b_1$ = reduced axial length vergence.

[Part Six of this paper will appear in the October issue]

HYPEROPIA IN LOW AMOUNT A FACTOR IN STUDENT'S DEPORTMENT—A CASE REPORT*

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HISTORY. Patient: boy, age 10. When first seen was in the fifth grade. He was introduced by his father as "Tough Charley." His teacher reports the boy a trouble maker; will not co-operate in any study class; all of his marks are "failing." The school nurse reports poor vision. The patient complains of headaches when he tries to read and the print doubles. He holds a book very close to his eyes. He sits in the front of the school room because the writing on the black board becomes blurry. His eyes get sore and itchy, and the parents report the eyes are bloodshot after school. The parents are concerned because he is not interested in school work and has become a behavior problem.

EXTERNAL EXAMINATION. Lids and conjunctiva are greatly injected. The pupils are about 6 mm. in diameter. The pupillary reflexes to light, direct and consensual, are of good amount and quality. Rotations and versions are full and complete. Convergence, by push-up, to 1½ inches, with pupil contraction.

OPHTHALMOSCOPIC EXAMINATION. Media are clear. Discs round and average size, the margins are well defined. The cup is about one third of the diameter of the disc in size, centrally located and normal depth. The blood vessels are of normal proportions and tortuosity. The fundi are healthy pink color and apparently normal.

VISUAL ACUITY. Upon Admittance, O.D. 20/25; O.S. 20/25; O.U. 20/25 plus.

TONICITIES. Upon Admittance, 2△ esophoria at 20 inches. Orthophoria at 13 inches.

STATIC SKIAMETRY. O.D. +1.25 D.sph.
O.S. +1.00 D.sph. ⊂ —0.50 D.cyl.axis 180.

DYNAMIC SKIAMETRY. Tait method.

Gross O.D. +2.75 D.sph.
O.S. +2.50 D sph. ⊂ —0.25 D.cyl.axis 180.

Physiologic Exophoria 4△. Allowance 1.50.

Net O.D. +1.25 D.sph.
O.S. +1.00 D.sph. ⊂ —0.25 D.cyl.axis 180.

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SUBJECTIVE FINDINGS.

O.D. +0.75 D.sph. ⌒ —0.25 D.cyl.axis 90.
O.S. +0.75 D.sph. ⌒ —0.25 D.cyl.axis 180.

Visual acuity O.D., O.S. and O.U. 20/20.
Visual acuity at 13 inches: normal.

TONICITIES. (with subjective findings in place)

1△ esophoria at 20 inches.
1△ exophoria at 13 inches.

FUSIONAL RESERVES.

P.R.A. 1.00 D.
PFC/PFR 17/25/12
N.R.A. 1.75 D.
NFC/NFR 14/21/19

Total Amplitude of Accommodation O.D. 9.00; O.S. 9.00.

SUMMARY. The final prescription given in this case was that shown in the subjective, to obtain the best vision with the maximum of plus sphere. After watching this case for two months we were able to record normal 20/20 vision in both eyes at distance and near with almost the normally expected fusional reserves and tonicities. The asthenopia diminished from the start and there was no discomfort after one month. The important point was the patient's renewed interest in his studies and the improvement in his grades. With this came such a noticeable change in his conduct and attitude that the teacher wrote a letter of commendation. His social behavior is now only that of any normal growing boy and the parents report that his grades are quite satisfactory.

20 S. FRONT STREET
PHILIPSBURG, PENNSYLVANIA

ABSTRACT

VISUAL PERFORMANCES BY OPHTHALMIC SERVICES. N. F. Stump and D. Carter. The Optometric Weekly. 38. 48. 1779-1781, and 38. 49. 1815-1817. 1947.

The authors present statistical data to show that industrial eye care programs consisting of job studies, visual surveys, refractions and the prescribing of glasses and orthoptics will do much to improve the visual acuity and eye comfort of the worker and increase his efficiency. It must be understood, however, that this is only true if the professional work is carried on in close conjunction with the worker's job analysis. The authors' before-and-after visual performance scores are rated on the ortho-rater. Several individual case reports are presented by the authors to show the type of program required. The authors also review some of the work of Skeffington.

C. C. K.

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SCIENTIFIC RESEARCH

The Academy is a non-profit organization which has for one of its aims the development and advancement of refractive and allied sciences. This specialized work, started by the Academy in 1931 and continued since that date, has resulted in a number of significant studies in both the basic or fundamental ocular sciences and the applied or developmental phases of our work.

Optometry as a profession is dedicated to the application of science to the correction of visual problems. Like most health workers, optometrists in general look down upon the basic sciences that cannot immediately be justified by some practical application in the refracting room.

On the other hand, its leaders recognize that optometry cannot advance without a firm foundation in basic science. The applied or developmental phases come from these and are expressed in our clinical procedures.

The early founders of the Academy recognized that fundamental research aimed at the acquisition of factual knowledge must necessarily precede the application of that knowledge for clinical purposes. Yet, because optometry is engaged in serving the public they well knew that both the fundamental and clinical sciences were necessary if optometry was to properly serve the public.

With this in mind the Academy has encouraged research studies wherever possible—always in the hands of capable men. Many of these projects have been completed and the results presented to the profession to enrich our literature and our knowledge of our work. These projects dealt with both fundamental and clinical science. Some projects were carried on by individuals working in their laboratories and offices. Most were undertaken and carried out in our schools under the most careful supervision. Some of these projects were individually financed or the costs were borne by the school. Some were financed by optical manufacturers and others received grants-in-aid of Academy funds. It is interesting to note that during this period the Academy has appropriated from its treasury approximately twelve thousand dollars to subsidize 15 of these special research studies, the most recent appropriations being announced by Bannon.[1]

As pointed out by Freeman,[2] these special studies start out with the formulation of a problem. Next a tentative answer is worked out which seems to satisfy some of the questions which have been developed. This answer is the hypothesis. Next, data are collected to test the hypothesis or to formulate a new hypothesis. The data are then classified and studied. From these studies an interpretation is made, and a tentative conclusion is reached. This conclusion is then verified by repeating the process as many times as the research worker considers necessary to validate his conclusion. There is no other authentic way of conducting research studies.

After the conclusion has been reached and verified the findings are then published, thus contributing, not only to ocular science, but all science in general.

The work of the Academy in encouraging and supporting research is bringing optometry to the attention of scientists in allied fields and will do much towards bringing about greater cooperation of trained minds to the end that refractive work will become more accurate and of greater value to the public.

CAREL C. KOCH

1. Bannon, Robert E. Academy Grants $3,500 for Visual Research. Am. J. Optom. & Arch. Am. Acad. Optom. 25.7.353-354. 1948.
2. Freeman, E. The Method of Science. Am. J. Optom. & Arch. Am. Acad. Optom. 25.4.153-161. 1948.

Obituary

WILLIAM BRAY NEEDLES

William Bray Needles, President of the Northern Illinois College of Optometry, died on June 5, 1948, after an illness of several years.

Dr. Needles was born May 17, 1879 in Sedalia, Missouri, and received his early education there and at Kansas City, Missouri, where in 1910 he founded the Needles Institute of Optometry. In 1926 this school became the Northern Illinois College of Optometry located in Chicago, Illinois.

From 1918 to 1923, in addition to his school work, he served the Department of Education of the American Optometric Association as a lecturer and teacher at optometric group meetings which were held in all parts of the country. In this latter activity, he traveled as part of the "flying squadron" team of optometric educators which became so well known and did such splendid work following World War I.

His activities as a lecturer continued until well into the second World War period and Dr. Needles was known and respected wherever optometrists gathered for his practical talks on refractive techniques and physiological optics.

His administrative skill coupled with his knowledge of optometric education enabled him to build the Northern Illinois College of Optometry into the largest school of its kind. Due to his efforts its alumni are found in every state and in many foreign countries.

Dr. Needles became a Fellow of the American Academy of Optometry in 1930.

In his personal contacts he possessed great charm and he was always at his best in conversation with small groups of optometrists. He brought to the science of ocular refraction a broad background of technical skill and clinical ability and to this he added a thorough knowledge of the literature. His memory will be a stimulating one for American optometry.

CAREL C. KOCH

TRANSACTIONS OF THE AMERICAN ACADEMY OF OPTOMETRY

A department devoted to announcements, reports, appointments, organization data, news, professional problems and ideals, as these relate to the Academy.

MEMBERS APPROVE CHANGES IN ACADEMY BY-LAWS

The proposed changes in the constitution and by-laws of the Academy recently submitted for vote have been approved by the membership and will go into effect immediately. The new constitution and by-laws will be published in the 1949 roster. Until the roster is published, Fellows are requested to write the Secretary for information on the amendments, or refer to the memorandum mailed to Academy members on June 24, 1948.

NOTES ON ANNUAL MEETING

For the first time since 1938, when the Academy met in Richmond, Virginia, Fellows will be heading South for their annual convention in December. For many, it will be not only their first trip to Winston-Salem, but their first trip to this beautiful mountain country.

This year, because of this, the program committee plans to allow more time during the convention for sight seeing in historic Winston-Salem, located at the foot of the Blue Ridge mountains in the rolling Carolina Piedmont.

Winston-Salem is a city rich with historic background. First, perhaps the history of the double name should be explained. A town called Salem was first settled in 1766 by a small group of Pennsylvania Moravians—a religious sect of United Brethren which traces its origin to the 14th Century. Later, Winston was founded (1849) a mile north of Salem. Gradually the two towns expanded until their borders met, and in 1913 citizens of both towns voted to consolidate into "Winston-Salem," or the "Twin-City."

Today, Winston-Salem is the leading industrial city of North Carolina, the manufacture of tobacco products being one of its principal industries. The R. J. Reynolds Tobacco Company, manufacturers of Camel cigarettes, is one of the many industries which is open to visitors. Dr. John D. Perry, Jr., Winston-Salem, and the local chapter have assured the Academy they will direct sight-seers to these places of interest, including Salem Tavern, an inn where Washington was once entertained.

Correspondence with Dr. Harold Simmerman, program chairman, indicates that all but the final o.k.'s are on the technical program sched-

uled for Winston-Salem. Speakers who for many years have enriched the Academy sessions with the latest in technical advances in the ocular field will again present papers, and several newcomers will also lecture.

Scheduled speakers include Dr. Robert E. Bannon, Columbia University; Dr. I. Irving Vics, Albany, New York; Dr. William Smith, orthoptics specialist, Boston; Dr. Meredith W. Morgan, Jr., University of California; Dr. Glenn A. Fry, The Ohio State University; Dr. S. Howard Bartley, Michigan State University; Dr. James H. Grout, Northern Illinois College of Optometry; Dr. Mathew Alpern, The Ohio State University; Dr. Monroe J. Hirsch, Stanford University; and Dr. H. W. Hofstetter, of The Ohio State University.

From Pennsylvania State College of Optometry will be Dr. Frederick W. Sinn, Dr. Robert Kratz, Dr. William G. Walton, Jr. Also lecturing will be Dr. Jerome B. Conlogue, Peoria, Illinois; Dr. Henry B. Day, Jr., Raleigh, North Carolina; Dr. Wilmot F. Schneider, Cleveland; Dr. Eugene Freeman, Chicago; Dr. Robert Graham, Pasadena, California; Dr. Richard Feinberg, Pacific University; Dr. Matthew Luckeish, lighting authority, Cleveland; Dr. William Feinbloom, New York City, and Dr. V. J. Ellerbrock, The Ohio State University.

As at previous conventions, there will be special sections on orthoptics, contact lenses, and aniseikonia for optometrists interested in these specialized fields. The program for these sections will appear in a later issue of this magazine, as will the entire program of speakers and their topics.

Chairmen of the committees for chartering Pullman cars for Winston-Salem are busy pouring over railroad timetables and consulting railroad officials. The important thing, they inform us, is for individual Fellows who plan to join a Pullman pool to contact their area chairman as soon as possible to assure the chairmen sufficient time to coordinate train connections. Further details on this matter should be secured by writing directly to one of the area chairmen of transportation listed below. (Chicago area Fellows please note the change in chairmanship for Chicago. Due to pressure of other work, Dr. Harry Pine has asked that he be replaced.)

NEW ENGLAND, MIDDLE EAST AND ATLANTIC SEABOARD

Dr. William Walton, chairman (Eastern Pennsylvania) 417 Anthwyn Road, Merion, Pennsylvania.

Dr. George Brown (New Jersey), 1311 Delaware Street, Paulsboro, New Jersey.

Dr. John Mogey (New York), Bank of Manhattan Building, New York, New York.

Dr. Leo Madigan, 59 Temple Place, Boston, Massachusetts.

Dr. Alton G. Billmeier (Maryland), Denton, Maryland.

NORTH CENTRAL, CENTRAL AND MIDWEST

Dr. J. C. Copeland, chairman (Illinois), Riggs Optical Company, 18 South Michigan Avenue, Chicago, Illinois.
Dr. Don B. Arden (Minnesota), Montevideo, Minnesota.
Dr. Ralph Wick (South Dakota), Woolworth Building, Rapid City, South Dakota.
Dr. G. H. Warkentine (Iowa), 634 Guaranty Building, Cedar Rapids, Iowa.
Dr. A. A. Schmidt (Cuyahoga), 708 Hippodrome Building, Cleveland, Ohio.
Dr. Herbert G. Mote (Central Ohio), 8 East Long Street, Columbus 15, Ohio.
Dr. W. E. Dewey (Michigan), Security Bank Building, Battle Creek, Michigan.
Dr. W. L. Van Osdol (Indiana), 605 State Life Building, Indianapolis, Indiana.

CHAPTER ACTIVITIES

FLORIDA

Fellows of the Florida chapter met at a special luncheon in conjunction with the Florida State Optometric Association in June. At this meeting, plans were made for attending the annual convention at Winston-Salem, and a constitution for the chapter discussed.

SOUTHERN CALIFORNIA CHAPTER

Southern California Fellows were joint sponsors of a special summer educational meeting of optometrists held in Temple City, California on August 7. The San Gabriel Valley Optometric Association and the Association of Professional Optometrists were the joint sponsors with the California chapter. The Los Angeles County Optometric Association attended as a guest group. Program chairman for the meeting was Dr. Robert Graham of Pasadena.

Over 100 Southern California optometrists, wives and children attended this special meeting.

Appearing on the educational program were Dr. Glenn Fry, Ohio State University, Dr. Meredith Morgan, University of California School of Optometry, and Mr. Kevin Tuohy of the College of Medical Evangelists, inventor of the corneal lens.

Dr. Fry reported on research being carried on by staff members of the Ohio State School of Optometry.

In his paper, Dr. Fry reported new knowledge of the visual mechanism resulting from four different investigations as follows:

The relation between cyclophoria and convergence: The same amount of cyclophoria is associated with accommodative convergence as with fusional convergence, with the implication that the same innervational pattern is involved in both types of response. However, the innervational pattern for these two responses is presumed to differ from that involved in turning both eyes from side to side. In this act no torsion is exhibited.

The relation between pupillary size and convergence: A reduction in pupil size occurs whenever accommodation, or accommodative convergence, are exerted. However, the change in pupil size associated with fusional convergence is relatively much less. This indicates a different pattern of innervation to fusional convergence. It has been demonstrated that *the accommodative convergence-accommodation ratio shows little or no change with age,* in spite of the fact that the amplitude of accommodation decreases with age. If the pattern of innervation to accommodation and convergence remains the same at different age levels, this finding would indicate that no greater contraction of the ciliary muscle is required to produce a diopter of accommodation at one age than at another. Experimenters find, *at the maximum level of accommodation, a tolerance to base-out prism which exceeds that manifested at lower levels of accommodation.* This indicates either that after accommodation reaches the maximum level, further contraction of the ciliary muscles can occur without affecting accommodation; or that subjects are not as capable of suppressing accommodative convergence under base-out stimulation at sub-maximal levels of accommodation as at the maximum level.

Dr. Morgan described developments in research on accommodation and convergence at Berkeley. He reported similar research to that at Ohio State University with essentially parallel results on all these various phases of the accommodative-convergence relationship. He thus corroborated the findings reported by Dr. Fry. With specific reference to the excessive ability to converge at the maximum level of accommodation, described in the preceding paragraph, he expressed the belief that the second conclusion is the correct one.

Mr. Tuohy reported on the present state of development of the corneal lens, stating that it is undergoing trials on over 50 patients with high incidence of success.

CURRENT COMMENTS

Virginia Huck
Editorial Assistant

Optometrists will confer a favor by sending news items of general interest for this department; such as relate to new instruments, clinical techniques, education, visual health and optometric legislation and organization.

BUREAU TO REVISE EYE BOOKLET

Once again, the better business bureaus in our major cities are bringing their pamphlet, "Facts You Should Know About Your Eyesight" up to date. The bureaus are consulting practicing optometrists and ophthalmologists to ascertain whether or not the facts in this little

booklet are still correct. The 16-page booklet is distributed by the local better business bureaus in an attempt to curb rackets in the visual field.

Optometrists who have not as yet seen the booklet might make it a point to do so, for it is well prepared and stresses to the public the need for only professional eye care. The booklet briefly defines errors in refraction and in clear language discusses anatomical, physiological and pathological defects. The public is warned of the dangers of eye treatment by mail or by unprofessionals in the field.

Distribution of this book started about 12 years ago and its message has reached thousands of persons through the efforts of the better business bureaus. It is periodically revised to keep abreast of scientific ocular development.

B & L OPENS NEW BIFOCAL PLANT

After many unforeseen delays, Bausch & Lomb's new bifocal lens plant has now swung into full scale production, at Rochester, New York. The building in which the new plant is housed was used by Bausch & Lomb during the war for the manufacture of military optical instruments. Following the war, the company carried out its pre-war plans of installing in the T-shaped building the latest in bifocal manufacturing equipment in anticipation of increased demand for bifocal lenses both here and abroad.

A pictorial glimpse of a few of the revolutionary processes now being used in the new plant can be found in the August issue of the Bausch & Lomb house organ: modern blocking machines; polishers; gauges; and many other recently developed manufacturing processes are pictured in the magazine, accompanied by brief explanations by officials of the company of the machinery and processes.

According to Theodore B. Drescher, vice president in charge of manufacturing, the capacity of the new plant, which also produces trifocals, is nearly double previous production at Bausch & Lomb.

OPTOMETRIC PROGRAMS

Reading dozens of press releases—as we do each month to get out this department—brings to light one indisputable fact about optometrists. They have an unlimited zeal for learning. With the exception of the war years when travel was limited, the national optometric calendar has been crammed constantly with seminars, conventions, refresher courses, and of course just plain get-togethers. The final quarter of 1948 will be no exception.

Optometrists of the Middle Atlantic states are hard at work on their fall Congress. Under the leadership of Dr. H. Ward Ewalt, Jr.

of Pittsburgh, committees have organized a program which includes a work-shop where practicing optometrists will be able to learn on instrumentation the various visual training techniques now in use.

Usually this Congress meets in the spring, but this year the annual conference is scheduled for October 10-13 in Pittsburgh. Dr. Darrel Boyd Harmon of Austin, Texas, an authority on lighting problems in our schools, will be one of the principal speakers. Dr. Fred Sutor and Dr. Emmett Betts, both of Philadelphia, and Dr. A. M. Skeffington will also speak.

On the West Coast, the University of California is offering a post graduate refresher course for optometrists in the field of patient psychology as it relates to the practicing optometrist.

Lectures start August 30, and continue through November 22. Topics of discussion include: "Statistics Needed by Optometrists," by Dr. William B. Michael, Ph.D., assistant professor of psychology, Princeton University; "How the Individual Responds to his Environment," by Joseph A. Gengerelli, Ph.D., associate professor of psychology, University of California; "Relation Between Images Falling on the Retina and the Perceptual Responses to Them," Gordon L. Walls, Sc.D., associate professor, physiological optics and optometry, University of California; "Learning Problems of Interest to Optometrists," Alvah R. Lauer, Ph.D., director of traffic research, Iowa State College, Ames; "Introduction to Some Clinical Psychiatric Problems," Karl O. Von Hagen, M.D. (practicing California physician); "Using Clinical Psychology in Handling Patients," Ray R. Cullen, M.A., private psychologist; "Problems of Child Psychology," Marion A. Wenger, Ph.D., associate professor of psychology, University of California. Enrollment is being handled by the University Extension division of the University of California, 813 South Hill Street, Los Angeles 14.

Pennsylvania State College of Optometry is again offering its annual graduate course in the fitting of contact lenses. The session begins August 27, and is over September 5. Interested optometrists should contact the Registrar, 6100 North 12th Street, Philadelphia 41, Pennsylvania.

In October, the North Central Optometric Educational Congress will meet in Minneapolis. Visual problems of school children will be the main topic of discussion. Among the speakers will be Dr. Paul Boeder, the American Optical Company. Reservations may be made through Dr. John W. Shimek, 426 Kresge Building, Minneapolis, Minnesota.